078272

US Army Corps of Engineers

Toxic and Hazardous Materials Agency

Work Plan and Field Sampling Plan Site Investigations

Fort Devens, Massachusetts

February 1992
Contract No. DAAA15-90-D-0012
Delivery Order No. 001
ELIN A004

20070502755

Prepared for:
Commander
U.S. Army Toxic and
Hazardous Materials Agency
Aberdeen Proving Ground, Maryland 21010-5401

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Final

THAMA Form 45, 1 Jul 90

Site Investigations Field Sampling Plan

Comments received from:

U.S. Environmental Protection Agency

Note: All comments have been retyped exactly as submitted.

Comment-01: Pg. 3-13, Section 3.6.2: See Comment #7. (Note: Per a 12 February 1992 telephone conversation with Mr. James P. Byrne, EPA Region 1, it was determined that the comment being referenced was EPA Comment #8 (renumbered as Comment-02 in the RI FSP Comment Response document). "...it should be noted that sediment samples should be taken from depositional areas in rivers, streams, and brooks. Also, sediment samples should be at least 30% solids. If these documents are to be "boilerplate" in the future, information like this must be included.")

Response: Two bullets have been added to Section 3.6.2 in response to this comment. The first two bullets of Section 3.6.2 now read:

- **All samples shall be collected from areas of deposition when sampling flowing water (i.e. streams, rivers, and brooks).**

- **All samples will, to the extent possible, contain no less than 30 percent solids. Exceptions may occur when sampling soft muds or organic (peat) deposits.**

Field Sampling Plan
Site Investigations
Fort Devens, Massachusetts

(February 1992)

Front Cover and Spine	Front Cover and Spine
Inside Cover	Inside Cover
Signature Page	Signature Page
Pages v and vi	Pages v and vi
Pages 3-13 through 3-22	Pages 3-13 through 3-22

Work Plan and Field Sampling Plan
Site Investigations
Fort Devens, Massachusetts

(December 1991)

Remove from Binder	Replace With
Front Cover and Spine	Front Cover and Spine

Work Plan

Please remove the entire SI WP from the binder and replace it with the complete final plan attached.

Field Sampling Plan

Remove from Binder	Replace With
Front Matter (cover page through p. xix)	Front Matter (cover page through p. xix)
Pages 1-1 and 1-2	Pages 1-1 and 1-2
Pages 2-1 through 2-4	Pages 2-1 through 2-4
Pages 2-7 through 2-23	Pages 2-7 through 2-23
Pages 3-1 and 3-2	Pages 3-1 and 3-2
Pages 3-7 and 3-8	Pages 3-7 and 3-8
Pages 3-13 through 3-22	Pages 3-13 through 3-22
Pages 4-1 and 4-2	Pages 4-1 and 4-2
Section 6 (pages 6-1 through 6-6)	Section 6 (pages 6-1 through 6-6)
Pages 9-3 through 9-6	Pages 9-3 through 9-6
Appendix B (pages B-1 through B-11)	Appendix B (pages B-1 through B-7)

Site Investigations Work Plan

Comments received from:

U.S. Environmental Protection Agency
U.S. Department of the Interior, Fish and Wildlife Service
Massachusetts Department of Environmental Protection

Note: All comments have been retyped exactly as submitted.

U.S. Environmental Protection Agency

General Comment: Although the maps contained within the draft final Plans are of markedly better quality than the draft Plans; EPA overall comment-07 was not addressed as the response indicated it would be.

Response: The sizes of the different AOCs and SAs differ markedly from one to another, ranging from a single small bunker to an 80 acre landfill area. It is impractical and unnecessary to display them each on the same scale, therefore varying scales have been used, each appropriate to the information displayed. As part of the SI and RI Reports, the maps of the SAs and AOCs will include at least one map of each at a scale of 1" = 100'.

Comment-01: Page xvi, Acronym List: On PARCC, change "Capability" to "Comparability"

Response: The definition of PARCC in the Acronym List has been changed. It now reads: Precision, Accuracy, Representativeness, Comparability, and Completeness.

Comment-02: Page 2-1; Section 2.1, 5th line Change "Townships" to "Towns".

Response: The use of the word townships has been changed to towns here and throughout all the plans.

Comment-03: Page 3-10; Section 3.5, Last Paragraph: The investigation will also concentrate inside the yards.

Response: The fenced DRMO yard consists of an asphalt surface surrounded by a 4 to 8 foot wide strip of soil. Due to the asphalt's generally impermeable surface, the focus of the investigation is to determine if surface run-off is contaminating soils inside the fenced perimeter. The text has been changed to clarify this. The last paragraph of Section 3.5, beginning with the second sentence now reads: The current investigation will primarily determine if surface contamination exists inside the DRMO yard along the perimeter. Collection of samples from locations throughout the yard is not feasible due to the relatively impermeable asphalt surface.

Comment-04: Response to EPA Comment-14 (from Overall Comments): Although E & E has added a section on the contents of the SI Report (see p. 5-18), there is little information as to the criteria for determining the need for further investigations at an SA. The purpose given for conducting these SIs on p. 1-1 of the Introduction also does not expand on the criteria to be used.

A meeting must be held between EPA, MDEP, E & E, Fort Devens and USATHAMA to discuss what criteria will prompt an SI Site to require further work (e.g. RI activities).

Response: The criteria for moving a site from an SI to an RI is the subject of a meeting to be held between USATHAMA, Fort Devens, and EPA in the near future. At this meeting it is hoped that all parties will reach agreement on what constitutes a site classified as no further remedial action planned (NFRAP), follow-on SI, or RI. In the interim, E & E's site work will focus on determining the presence and types of hazardous substances, and the potential for migration and contact with the public and the environment.

Comment-05: Page 4-12; Section 4-7: E & E indicated that groundwater samples will be analyzed for TCL, TAL, TPH, and TPHC. Please remove one of the citations for TPH unless there truly is a difference.

Response: TPH has been deleted from the list of analyses referenced. The fifth sentence, second paragraph of Section 4.7 now reads: The analytical phase requires that two rounds of groundwater samples be collected from each of the three new wells, at least 3 months apart, and analyzed for TCL, TAL, TPHC, and for some common ions (calcium, magnesium, potassium, bicarbonate chloride, sulfate, nitrate, total Kjeldhal nitrogen, and dissolved oxygen).

Comment-06: Page 5-8; Section 5.4.6, Last Bullet: EPA would like to request a copy of this report when it becomes available.

Response: A copy of the report summarizing UXO operations performed during field operations will be delivered to USATHAMA. Your request for a copy of this report has been forwarded to Ms. Mary Ellen Heppner.

Comment-07: Pages 5-11 thru 5-13; Section 5.5: This Section is a good start on a waste minimization/pollution prevention plan for the CERCLA investigation and cleanup. EPA would like to work with the Army and its contractor on future Work and Field Sampling Plans to further manage and minimize the amount of waste generated by the CERCLA work at Fort Devens.

Response: No text change has been made to the plan in response to this comment. EPA's desire to work with the Army and its contractor should be coordinated with Fort Devens and USATHAMA in a comprehensive waste minimization program.

Comment-08: Page 5-12; Section 5.5.2: Triple bagging non-contaminated refuse seems like overkill. Consider one trash bag for this in the future.

Response: The text has been changed as suggested and a single plastic bag will be used for non-contaminated refuse in the future. The last sentence of the second paragraph in Section 5.5.2 now reads: Non-contaminated refuse will be placed in a plastic bag and disposed of as regular trash.

Comment-09: Page 5-13; Section 5.6: EPA would also like to request a copy of this report when it becomes available.

Response: The reports referred to in Section 5.6 are interim reports on field activities necessary to complete the QA requirements of the contract and will be integrated into the final report. As such they are not considered to be formal document submissions.

U.S. Department of the Interior, Fish and Wildlife Service

Comment-01: The nature and extent of contamination at SA 15 are of particular interest to the FWS. In addition to the biota in the Nashua River and Slate Brook Pond, the impact, if any, from the former landfill upon the fish and wildlife resources in the Oxbow National Wildlife Refuge is of concern. If SI soil borings results indicate a contaminent problem, surface water and sediment sampling should be considered in these nearby ecologically sensitive areas.

Response: If contamination in the SI soil borings is found, the recommendation for additional sampling in ecologically sensitive areas will be considered and will be discussed in the conclusions section of the SI report.

Massachusetts Department of Environmental Protection

Comment-01: Section 4.2, paragraph five. According to paragraph five the selection of the soil boring locations will be made by EPA, Fort Devens, USTHAMA, and Contracting Officer or Contractor's Technical Representative. Provisions should be made to include the State in the borehold selection process.

Response: The text in paragraph five of Section 4.2 has been changed to include MDEP in the borehole selection process. The text now reads: The selection of appropriate locations will be made in the field after all pertinent data have been reviewed with the Fort Devens Installation engineers, EPA, MDEP, and the Contracting Officer/Contracting Officer's Technical Representative.

Comment-02: Selection 3.4, page 3.6. It is still unclear as to the location of the removed soil. It is unclear whether the soil was relocated within the boundaries of Zulu I & II or relocated within the Fort Devens installation. Please supply more specific detail on this matter.

Response: Section 3.4 has been changed not only to clarify what has been done with the potentially contaminated soil, but also to correct the statement that the soil was periodically removed in an effort to control migration of contaminants.

The fifth sentence in the first paragraph of Section 3.4 has been deleted and replaced with: There is no evidence of removal of soils and material from the two ranges. However, the Zulu ranges are occasionally scraped and cleaned to improve appearance.

Comment-03: Section 3.5, last paragraph. Unless the soil analysis indicates that the soil has not been contaminated, this area should be included in the site investigtion of SA 32. Please indicate if this area has been included in the sampling protocol. It would be helpful if the area in question was identified on the map 3-5 of the work plan and/or 2-4 of the field sampling plan.

Response: A number of investigations have been undertaken by other agencies at the DRMO besides the SI work currently underway. There have been recent spills of materials and cleanup actions. Fort Devens Environmental Management office conducted wipe tests for PCBs in late October 1991. AEHA is conducting a detailed sampling program of the spill areas. In addition, removal actions are occurring as evidenced by open excavations.

The fenced DRMO yard consists of an asphalt surface surrounded by a 4 to 8 foot wide strip of soil. Due to the asphalt's generally impermeable surface, the focus of the SI investigation being conducted by E & E is to determine if surface run-off is contaminating soils inside the fenced perimeter. The text has been changed to clarify this. The last paragraph of Section 3.5 has been changed. Starting with the second

sentence it now reads: The current investigation will primarily determine if surface contamination exists inside the DRMO yard along the perimeter. Collection of samples from locations throughout the yard is not feasible due to the relatively impermeable asphalt surface.

In response to this comment Figure 3-5 has also been changed to include a reference to the past spill site.

Comment-04: Section 5.4.4, paragraph five. Please clarify what is meant by "well volumes". The wells should be purges until turbidity is reduces to the extent practicable.

Response: The fifth paragraph of Section 5.4.4 has been changed in response to this comment. The third, fourth, and fifth sentence of that paragraph now read: USATHAMA geotechnical requirements are that, during development, at least five times the volume of water standing in the well casing and five times the volume of water added to the well during drilling shall be removed from the well. The turbidity of the water also has to be reduced to the extent practicable. Water cannot be added to aid in development.

Site Investigations Field Sampling Plan

Comments received from:

U.S. Environmental Protection Agency
U.S. Department of the Interior, Fish and Wildlife Service
Massachusetts Department of Environmental Protection

Note: All comments have been retyped exactly as submitted.

U.S. Environmental Protection Agency

Comment-01: Page 2-21; Section 2.3.5: Trip blanks - Region I QC policy for trip blanks is that 1 trip blank per 10 volatile organic samples, regardless of matrix (eg. water and soil), or 1 trip blank per cooler, whichever is greater, should be provided. If this was not done as part of the SI/Ri phase of the investigation, future work should take this guidance into consideration.

Response: This paragraph has been changed to reflect EPA policy. In Section 2.3.5, the fifth sentence under Trip Blanks now reads: One trip blank will be used with every cooler of samples, or 1 trip blank per 10 volatile organic samples (regardless of matrix) will be used, whichever is greater.

U.S. Department of the Interior, Fish and Wildlife Service

Comment-01: Page 2-16. Although Table 2-5 lists hardness and grain size in the surface water and sediment analyses, respectively. The text (pg. 3-13 & 14) in Field Procedures and the tables in Appendix B do not include these parameters.

Response: The reference to hardness and grain size has been added to Appendix B. The text in Section 3.6 has not been changed since it describes the procedures for collecting water and sediment samples rather than the required analyses. However, the text in Section 2.3.2 has been modified to include a reference to grain size for sediment samples. Hardness was already included for water samples. The third and fourth sentences of the second paragraph in Section 2.3.2 read: In addition, the 10 sediment samples will be analyzed for Total Organic Carbon (TOC) and grain size, while the 10 surface water samples will also be analyzed for hardness. For the water samples, dissolved oxygen, pH, and specific conductance will be measured in the field.

Massachusetts Department of Environmental Protection

Comment-01: Section 7.9 of the Remedial Investigation Work Plan (RIWP) describes a procedure for obtaining background soil samples. No discussion appears in either the workplan or the sampling plan for site investigation activities on how background samples will be taken. This submittal can be provided in the same format as section 7.9 in the RIWP. A map showing the areas where the background will be taken should be included. This map should show the potential locations of background soil samples with regards to the identified study areas.

Response: All background or regional soil sampling is being collected under the RI program activities. These data will be made available to the SIs but are not normally provided in an SI study and are not included in this work plan/field sampling plan.

Comment-02: Section 3.3 paragraph one. Please clarify whether all seven wells identified in this paragraph are shallow wells.

Response: The text has been changed to indicate that all seven wells discussed here are shallow wells. The first sentence of Section 3.3, paragraph one, now reads: The groundwater investigation program for the SI sites includes the installation of four shallow (25 to 40 foot) groundwater monitoring wells at SA 25 and three shallow (35 to 40 foot) groundwater monitoring wells at SA 48.

Comment-03: Section 3.8. For the slug test as described in this section it is recommended that the rising head slug test be done on wells screened across the water table. Falling head slug test are recommended for wells screened entirely beneath the water table. The Department recommends that the contractors use effective lengths for the screens. The contractor should also supply calculations/methods used as well as clearly defining any variables.

Response: E & E believes the commenter's recommendations are accommodated in the existing Section 3.8. The process described in Section 3.8, and analytical method incorporated by reference (Bouwer and Rice (1976), provide the information requested.

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US Army Corps
of Engineers

Toxic and Hazardous
Materials Agency

Work Plan
Site Investigations
Fort Devens, Massachusetts

December 1991
Contract No. DAAA15-90-D-0012
Delivery Order No. 001
Data Item A004

Prepared for:
Commander
U.S. Army Toxic and
Hazardous Materials Agency
Aberdeen Proving Ground, Maryland 21010-5401

Prepared by:
ecology and environment, inc.
1700 North Moore Street
Arlington, Virginia 22209

Final
THAMA Form 45, 1 Jul 90

UC2032/RC151

WORK PLAN
FOR SITE INVESTIGATIONS AT
STUDY AREAS 15, 24, 25, 26, 32, 48

FORT DEVENS, MASSACHUSETTS

Contract No. DAAA15-90-D-0012
Delivery Order No. 0001
ELIN A004

December 1991

Prepared for:

UNITED STATES ARMY TOXIC AND
HAZARDOUS MATERIALS AGENCY
Aberdeen Proving Ground, Maryland 21010-5401

Prepared by:

Ecology and Environment, Inc.
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Robert J. King
E & E Project Manager

Lewis Welzel
Program Manager

PREFACE

On 13 May 1991, the United States Department of the Army and United States Environmental Protection Agency finalized and signed a Federal Facility Agreement for the conduct of environmental studies and remediation activities at the Fort Devens Army Installation in Massachusetts. This inter-agency agreement was prepared under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and covers a broad spectrum of environmental restoration activities at Fort Devens. One part of the agreement deals with site inspections (SIs) (also referred to as site investigations) and remedial investigation (RI) activities at several defined locations at Fort Devens. The purpose of the SIs is to evaluate existing data about study areas (SA) to determine the presence of toxic and hazardous materials, or the potential threat to human health and the environment. Wherever contamination is indicated by the historical use of the study area, appropriate samples of soil, sediment, water, and air are collected and analyzed to better determine the extent of the threat posed to human health and welfare, and the environment. If a threat or a significant potential threat is determined to exist, the study area is designated an area of contamination (AOC) and is recommended for the next phase of evaluation, the RI.

The purpose of the RI is to fully characterize a known, contaminated site to determine the extent of contamination and to identify the significance of the hazards posed by the site. The RI requires extensive sampling and monitoring to gain a precise understanding of the site and to allow investigators to collect sufficient information for follow-on recommendations on the best methods to remediate the site.

On 21 September 1990, the United States Army Toxic and Hazardous Materials Agency (USATHAMA), under Contract No. DAAA15-90-D-0012, assigned a delivery order to Ecology and Environment, Inc. (E & E) for the conduct of SIs at six locations and RIs at four areas (three of which are co-located) within Fort Devens. In order to properly conduct work at these sites, E & E developed seven draft plans: the Remedial Investigation Work Plan, the Remedial Investigation Field Sampling Plan, the Site Investigation Work Plan, the Site Investigation Field Sampling Plan, the Health and Safety Plan, the Quality Assurance Project Plan, and the Community Relations Plan. The draft plans were reviewed extensively and comments were received from the Department of the Army (USATHAMA and Fort Devens), EPA Region I, the Massachusetts Department of Environmental Protection, the United States Fish and Wildlife Service, as well as the general public. E & E issued a formal response to these comments on 17 June 1991, and on 19 August, 1991 E & E issued revised Final Draft plans, which were again submitted for review and comment. On 10 October 1991, E & E received comments on the final draft plans from the reviewing agencies. E & E modified the plans in accordance with the comments, and a formal response to the final comments is attached to the transmittal letter for this report.

Concurrent with the revision process, field teams prepared for the field sampling program by drilling necessary monitoring wells, and collecting samples to characterize portions of the areas under investigation. Where feasible and appropriate, the plans have been modified to reflect the actual conditions and actions taken during the early stages of field work.

This part of the final plan is one of seven prepared for the Fort Devens delivery order. Appropriate information is cross-referenced among the plans to ensure a complete and accurate portrayal of planned activities without extensive repetition. The seven plans are grouped into five binder sets: the RI Work Plan and RI Field Sampling Plan, the SI Work Plan and SI Field Sampling Plan, the Community Relations Plan, the Health and Safety Plan, and the Quality Assurance Project Plan.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Government Industrial Hygienists
ADL	Arthur D. Little, Inc.
AIHA	American Industrial Hygiene Association
ANL	Argonne National Laboratory
AOC	Area of Contamination
APR	Air Purifying Respirator
ARAR	Applicable or Relevant and Appropriate Requirement
ASC	Analytical Services Center
ASTM	American Society for Testing and Materials
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHSO	Corporate Health and Safety Officer
CLP	Contract Laboratory Program
CMR	Code of Massachusetts Regulations
COC	chain-of-custody
COTR	Contracting Officer's Technical Representative
CPR	Cardio-Pulmonary Resuscitation
CRC	Community Relations Coordinator
CRL	Certified Reporting Limit
CRP	Community Relations Plan
CVAA	Cold Vapor Atomic Absorption
CWA	Clean Water Act
2,4-D	2,4-dichlororophenoxyacetic acid
CV	Cold vapor
dBA	decibels
DCA	dichloroethane
DCE	dichloroethylene
DDT	dichlorodiphenyltrichloroethane

DEH	Directorate of Engineering and Housing
DERA	Defense Environmental Restoration Account
DIO	Directorate of Industrial Operations
DO	dissolved oxygen
DOD	United States Department of Defense
DOE	United States Department of Energy
DOT	United States Department of Transportation
DPCA	Directorate of Personnel and Community Activities
DQO	Data Quality Objectives
DRMO	Defense Reutilization and Marketing Office
ECD	Electron Capture Detector
E & E	Ecology and Environment, Inc.
EE&G	Environmental Engineering and Geotechnics, Inc.
EOD	Explosive Ordnance Demolition
EP	Extraction Procedure
EPA	United States Environmental Protection Agency
FID	Flame Ionization Detector
FOIA	Freedom of Information Act
FORSCOM	United States Army Forces Command
FR	Federal Register
FS	Feasibility Study
FSO	Field Safety Officer
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Gas Furnace Atomic Adsorption
HASP	Health and Safety Plan
HEPA	High Efficiency Particulate Absolute
HMX	cyclotetramethylene tetranitramine
HNU	HNU Inc., Manufacturer of Photoionization Detector
HPLC	High-Performance Liquid Chromatography
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendments
IAG	Inter-Agency Agreement
ICP	Inductively Coupled Argon Plasma Spectrometry

IDLH	Immediately Dangerous to Life and Health
IR	Installation Restoration
IRDMIS	Installation Restoration Data Management Information System
IRP	Installation Restoration Program
IT	International Technologies Corporation
KO	Contracting Officer
LCL	Lower Control Limit
LEL	Lower Explosive Limit
LOF	Lack of fit
LWL	Lower Warning Limit
MAAF	Moore Army Airfield
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDEP	Massachusetts Department of Environmental Protection
MDWPC	Massachusetts Division of Water Pollution Control
MEP	Master Environmental Plan
MGL	Massachusetts General Law
MS	Mass Spectrometry
MSA	Mine Safety Association
MSDS	Material Safety Data Sheet
MINIRAM	Miniature Real-Time Aerosol Monitor
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSHA	Mine Safety and Health Administration
MSL	Mean Sea Level
NA	Not Analyzed
ND	Not Detected
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
No.	Number
NPDES	National Pollutant Discharge Elimination Systems
NPL	National Priorities List
NRWA	Nashua River Watershed Association
OCLL	Office of the Chief of Legislative Liaison
OCPA	Office of the Chief of Public Affairs

OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Detector
PA	Preliminary Assessment
PAO	Public Affairs Office
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
POL	Petroleum, Oil, and Lubricant
PP	Proposed Plan
PPE	Personal Protective Equipment
PPM	Parts Per Million
PRI	Potomac Research, Inc.
PSI	Pounds Per Square Inch
PVC	Polyvinyl Chloride
QAPjP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	hexahydro-1,3,5,-trinitro-1,3,4-triazine
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPD	Relative Percent Difference
RPM	Remedial Project Manager
SA	Study Area
SARA	Superfund Amendments and Reauthorization Act of 1986
SAS	Special Analytical Services
SCBA	Self-Contained Breathing Apparatus
SDVB	Styrene/Divinylbenzene
SDWA	Safe Drinking Water Act
SI	Site Investigation
SOP	Standard Operating Procedure

SOW	Statement of Work
SSHC	Site Safety and Health Coordinator
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit (Replaced by AOC or SA in these plans)
TAG	Technical Assistance Grant
TAL	Target Analyte List
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TKN	Total Kjeldhal Nitrogen
TLD	Thermoluminescent Dosimeter
TNT	Trinitrotoluene
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TPHC	Total Petroleum Hydrocarbons
TRC	Technical Review Committee
TSCA	Toxic Substances Control Act
TSDA	Temporary Storage and Disposal Area
TSS	Total Suspended Solids
UCL	Upper Control Limit
USACE	United States Army Corps of Engineers
USAEHA	United States Army Environmental Hygiene Agency
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	Underground Storage Tank
UV	Ultraviolet
UWL	Upper Warning Limit
UXB	UXB International, Inc.
UXO	Unexploded Ordnance
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

WWTP	Wastewater Treatment Plant
ZI	Zero Intercept

UNITS OF MEASURE

Btu	British thermal unit(s)
°C	degree(s) Celsius
cfs	cubic feet per second
cm	centimeter(s)
d	day
°F	degree(s) Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
gal	gallon(s)
g	gram(s)
gpm	gallons per minute
h	hour(s)
in.	inch(es)
l	liter(s)
lb	pound(s)
m	meter(s)
mg	milligram(s)
mi	mile(s)
min	minute(s)
mo	month(s)
ppb	part(s) per billion
ppm	part(s) per million
s	second(s)
ton	short ton(s) (i.e. 2000 pounds)
wk	week(s)
yd^3	cubic yard(s)
yr	year(s)
µg	microgram(s)
µmho	micromho(s)

1. INTRODUCTION

In accordance with U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) Delivery Order No. 0001 of Contract No. DAAA15-90-D-0012, Ecology and Environment, Inc. (E & E) will be performing site investigations (SIs) at six areas identified for further study on the Fort Devens military installation in Worcester and Middlesex counties in central Massachusetts.

A list of areas to be characterized for environmental investigation was initiated during 1985, when Fort Devens applied for a Resource Conservation and Recovery Act (RCRA) Part B Permit for its hazardous waste storage facility. The list included all Solid Waste Management Units (SWMUs) that showed potential for release of hazardous waste to the environment. In 1986, a final permit was issued along with a list of SWMUs. In accordance with the terms of the Federal Facilities Agreement between the United States Department of the Army and the United States Environmental Protection Agency for Fort Devens, areas formerly identified as SWMUs at Fort Devens are referred to as Study Areas (SAs) and Areas of Contamination (AOCs) for purposes of environmental restoration.

The purpose of these SIs is to provide the Army with environmental information on SAs as identified in the Master Environmental Plan (MEP). The data will identify if contamination exists at these sites and if further investigation is warranted.

This Work Plan has been developed to comply with Massachusetts Department of Environmental Protection (MDEP) hazardous waste regulations; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, the corrective action provisions of the 1984 Hazardous and Solid Waste Amendments (HSWA), and the Toxic Substances Control Act (TSCA).

Section 2 of this plan provides a brief description of the history and physical setting of the Fort Devens area, and a summary of the locations listed for environmental studies under the MEP. Section 3 provides a detailed description of each of the SAs included for SIs, while Section 4 describes planned activities at each SA. The overall project plan for SI activities is described in Section 5, and Section 6 describes the personnel requirements for conducting the assigned tasks. The SI schedule is presented in Section 7.

2. GENERAL SITE HISTORY AND NATURAL SETTING

2.1 PHYSICAL SETTING

Fort Devens is located on approximately 9,400 acres of land, approximately 35 miles west of Boston, Massachusetts, in Middlesex and Worcester counties (Figure 2-1). The City of Worcester is approximately 20 miles south of the installation. The installation borders the towns of Ayer, Harvard, Lancaster, and Shirley. The installation is divided into three parts, or posts (Figure 2-2). The North Post (1,500 acres) is separated from the Central Post by Ayer's Main Street, which crosses Fort Devens east to west. The North Post contains Moore Army Airfield (MAAF), the wastewater treatment plant (WWTP), and training areas. The Central Post (2,300 acres), commonly referred to as the Main Cantonment Area, contains administrative and support facilities. The South Post (5,600 acres), which is separated from the Main Cantonment Area by State Route 2, contains ranges and training areas.

As discussed below, the site's physical setting includes physiography, surficial deposits, soils, stratigraphy/lithology, regional hydrogeology, climate, and vegetation.

2.1.1 Climate

The climate of the Fort Devens area is characterized by long cold winters and short warm summers. Temperatures vary from a monthly average of 24°F in January to 71.9°F in July. Precipitation totals 43 inches on average, this includes 69.4 inches of snow per year. Precipitation is generally uniform throughout the year, averaging 3 to 5 inches per month. July, the driest month, averages 3.36 inches of precipitation, and November, the wettest month, averages 4.49 inches of precipitation (USDA, 1985).

Winds are moderate with a mean annual wind speed of approximately 4 miles per hour, and a predominance of westerly winds. The climate is generally variable, due to fluctuating influences from polar and tropical air masses, and marine and continental air flows. Extremes of cold and heat are brief episodes, and extremes of precipitation are typically due to remnants of tropical storms, or brief, violent localized thunderstorms in summer.

2.1.2 Vegetation

The highly varied topography, soils, and drainage of Fort Devens, in combination with human interference, have resulted in a patchwork of forest, marsh, grassland, and open water. Managed forest accounts for approximately 70 percent of land cover. The climax/sub-climax vegetation is predominantly deciduous northern hardwood/pine forest, with red oak and white pine predominating in drier areas and red maple and ash in wetter areas. Palustrine wetland is common in small areas along streams, around wetlands, and open water, as are marshes and bogs.

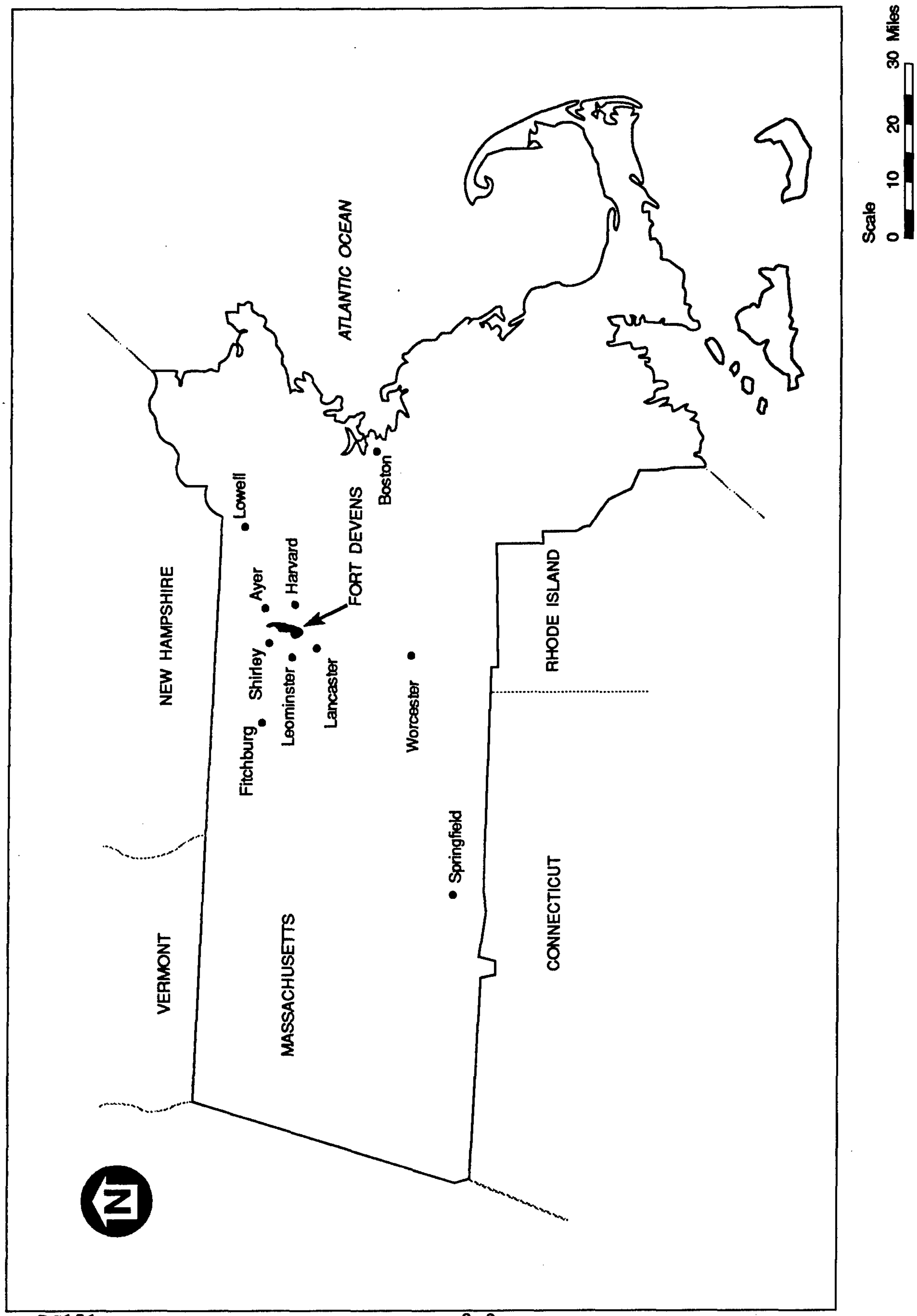
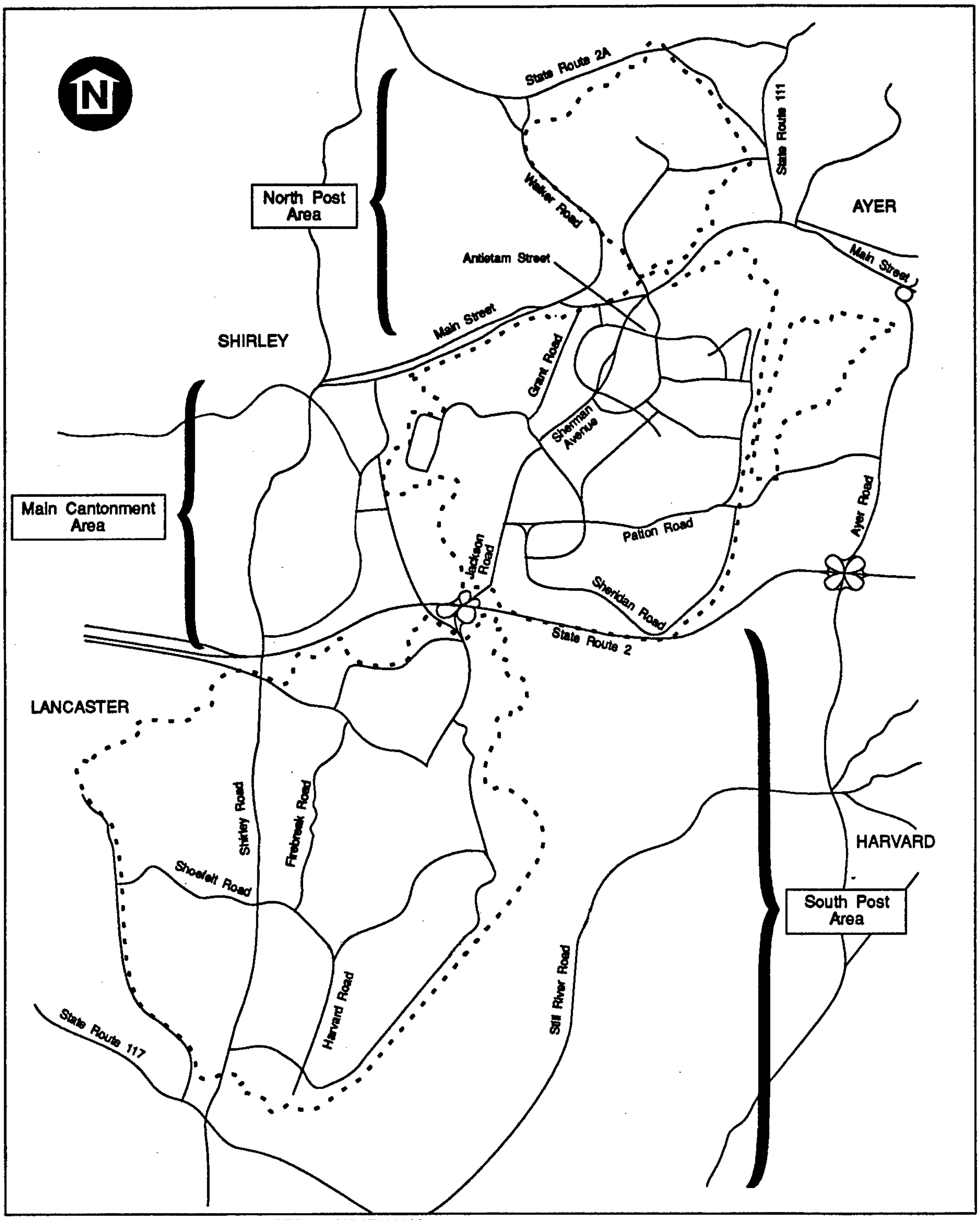


Figure 2-1 LOCATION OF FORT DEVENS IN MASSACHUSETTS



Source: Interagency Agreement USEPA / USATHAMA

Legend

——— Road

- - - Installation Boundary

Scale in miles

1 3/4 1/2 1/4 0 1

Figure 2-2 LOCATION OF THE NORTH POST, MAIN CANTONMENT, AND SOUTH POST AREAS

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Open water occurs in kettle hole lakes such as Mirror Lake and Robbins Pond, and in artificially enhanced impoundments such as Plow Shop Pond and the pond alongside Cold Spring Brook Landfill. Abandoned oxbows along the Nashua River, as well as the river itself, also provide open bodies of water.

Grassland is artificially maintained in the ranges of the South Post and in much of the developed areas of the North Post, such as the airport. In addition, grassland is artificially maintained in the recreational areas such as the golf course and playing fields.

2.1.3 Regional Setting

Fort Devens is near the western boundary of the Seaboard Lowland Section of the New England-Maritime Physiographic province (Jahns, 1953). It is adjacent to the Worcester County Plateau of the Central Uplands province and part of the installation lies within that province (Koteff, 1966). The area constitutes a small part of a lowland belt in which Pleistocene glacial and post-glacial deposits form a discontinuous mantle over Paleozoic crystalline igneous and metamorphic bedrock. These surficial deposits thin to the west as the relief increases to approximately 500 feet in the plateau region.

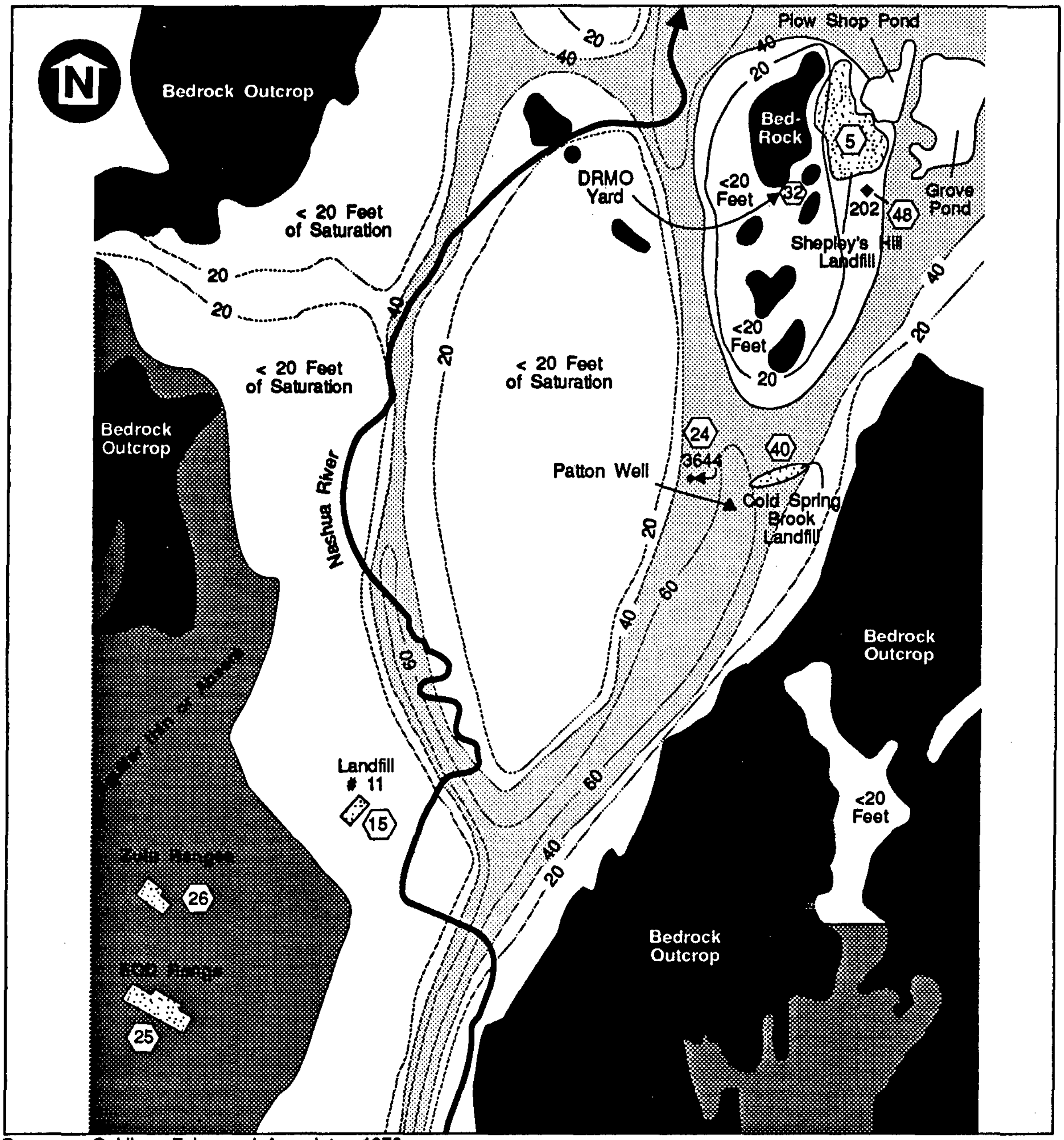
The geomorphology of Fort Devens exhibits a typical continental glacial terrain with ice contact features. A pitted outwash plain, dotted with small conical and drumlinoid hills, is the most conspicuous geomorphologic feature on the installation; the plain was formed by glacial deltas prograding into various stages of glacial Lake Nashua (Koteff, 1966). Sand and gravel were deposited by the deltas around blocks of stagnant ice, and as the block ice melted, depressions known as kettles developed. Robbins Pond, Mirror Lake, Little Mirror Lake (formerly named Little Hell Pond), and Cranberry Pond are excellent examples of kettle lakes. Conversely, crevasses and depressions that were filled with the same detritus formed the small conical hills and terraces known as kames and kame terraces/plain. The terrace upon which the rapid infiltration sand beds are located, west of the Fort Devens airport, is an excellent example of a kame terrace. Drumlins or drumlin-like hills with cores of bedrock such as Shepley's Hill and Whittemore Hill are also in evidence on the installation. In these two cases the hills are not strictly drumlins, which are defined as "a streamlined hill or ridge of glacial drift with long axis paralleling the direction of flow of a former glacier." They are, however, partly mantelled with glacial till, and evidently shaped by glacial ice into elongated ridges with axis parallel to the direction of flow of the former glaciers. Other evidence of glacial activity includes the following features: poorly drained swampy areas (primarily in the South Post) which suggest ground moraine; and eskers (formed as channel till under the ice) such as the ridge located between Mirror Lake and Little Mirror Lake.

Surficial deposits, which mantle Fort Devens, are largely glacial in origin from the Pleistocene era (Jahns, 1953; Koteff, 1966; Schnieder, et al., 1975). These deposits consist of two primary types: (1) glacial till consisting of poorly sorted clays, silts, sands and gravels; and (2) glacial-deltaic outwash deposits consisting of sand, gravel, and boulders. Outwash deposits of sand and gravel are from the Clinton, Pin Hill, and Ayer stages of the retreat of the ice, respectively (Jahns, 1953; Koteff; 1966; Schnieder, et al., 1975) and approach 100 feet in thickness (Koteff, 1966). Also present are glacial lacustrine deposits consisting of approximately 30 feet of sands and clays, which were deposited in glacial Lake Nashua. On Fort Devens, thin deposits of glacial till are exposed on Shepley's Hill and Whittemore Hill drumlins. However, in most cases, the till has been eroded and covered by the younger outwash deposits. According to Koteff (1966), the average thickness of the till is 10 feet in the Clinton area south of the installation. Conversely, Jahns (1953) reports that the till deposits have approached a thickness of 300 feet near Ayer.

Groundwater at Fort Devens occurs largely in the permeable glacial-deltaic outwash deposits of sand, gravel, and boulders.

A study by Goldberg-Zoino and Associates for the Montachusetts Regional Planning Board (1976) shows the estimated thicknesses of saturated glacial sediments within the study area and clearly indicates the major preglacial valleys, probably deepened by glaciation, which contain the more productive aquifers (see Figure 2-3). Because of the highly irregular nature of the bedrock surface, and the scattered distribution of wells, the accuracy and degree of detail on the distribution of aquifers as recorded by Goldberg-Zoino depended on the distribution of wells and boreholes.

Small amounts of groundwater can be obtained from fractured bedrock with yields ranging from 2 to 10 gpm. Well yields within the glacial sediments are dependent on the hydraulic characteristics of the aquifers and range from 0 to >300 gpm. Minor amounts of groundwater may be found in thin, permeable glacial lenses elsewhere on the installation. These zones may occur as multiple perched zones and in some cases exit the ground surface as springs and seeps. Springs are very common around the circumference of the artillery impact area in the South Post. Depth to the water table ranges from 0 to 90 feet. The specifics of groundwater flow directions are controlled by bedrock and till topography, and surface drainage, since groundwater in the glacial sediments is connected to surface water. Some control will also be the result of variations in hydraulic conductivity of the glacial sediments, but most show moderate to high hydraulic conductivities, being predominantly sand, gravel, and cobbles of outwash or lacustrine origins. Till and bedrock outcrops occur primarily as bedrock hills or drumlins and are typically groundwater divides.



Source: Goldberg-Zoino and Associates 1976.

Scale in Feet
2500 0 2500

Legend

- (25) Study Areas with Number
- Areas of Greater than 40 Feet of Saturation
- Areas of Glacial Sediment Where the Zone of Saturation is Thin or Absent
- Areas of Bedrock
- ---20--- Isopachs (feet) of Saturated Thickness

Figure 2-3 DISTRIBUTION OF GLACIAL SEDIMENTS AND BEDROCK SHOWING SATURATED THICKNESS ISOPACHS IN SEDIMENTS

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The Nashua River Basin encompasses approximately 543 square miles (1,405 Km^2) (Brackley and Hansen, 1977). The river flows through the installation in a south to north direction and discharge rates average 55 cfs (1.55 cms). Depths range from 1 to 13 feet (0.3 to 4 m). The drainage patterns are controlled by both surficial deposits and bedrock structure. In 1982, a 100 year flood occurred on the installation covering those areas mapped as Quaternary alluvial deposits on the surficial geology maps. In addition to the Nashua River, the terrain is dissected by numerous brooks that are associated with attendant wetlands. As indicated in Figure 2-4, there are several kettle ponds and one kettle lake located within the installation boundary.

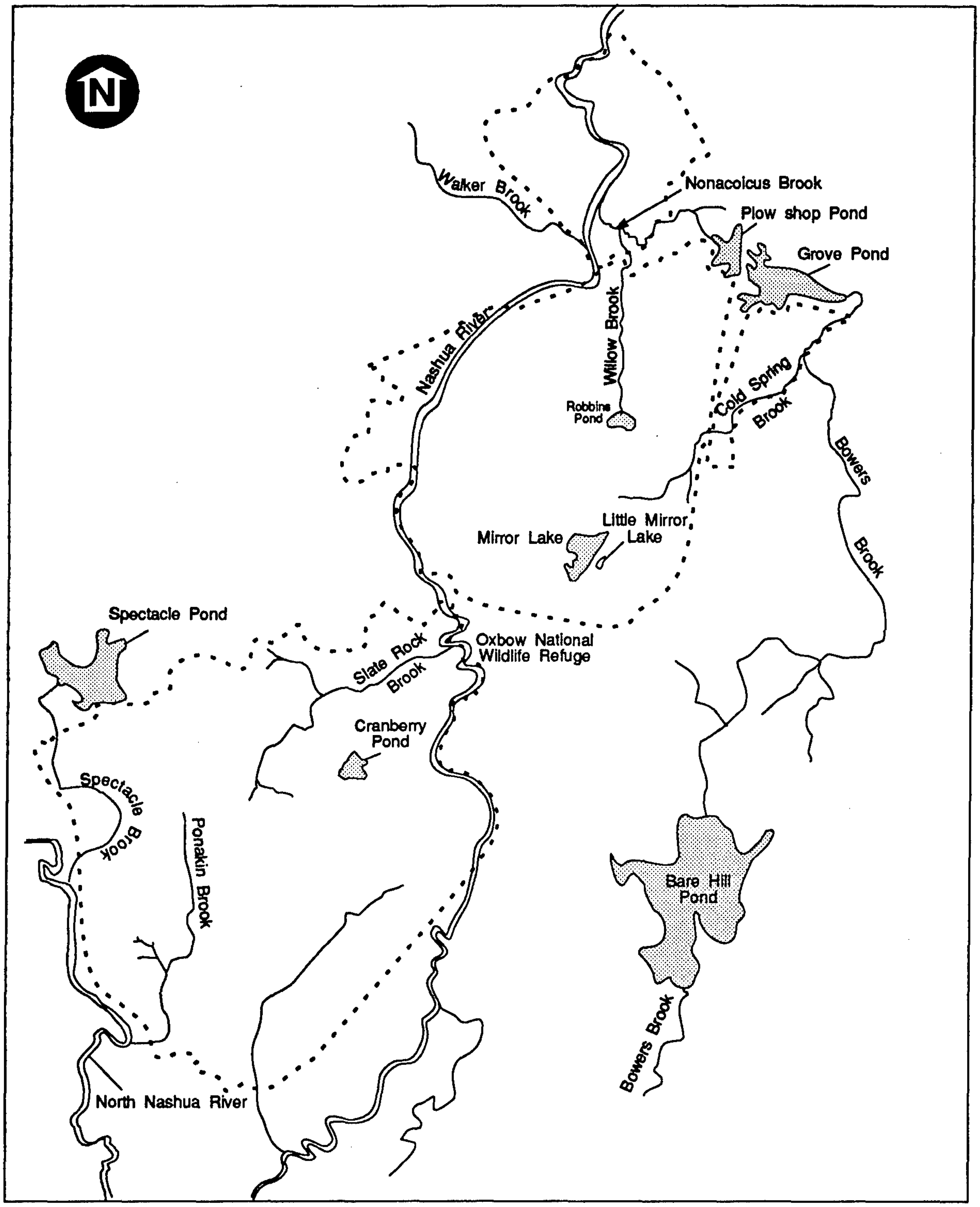
Within Fort Devens, several small streams drain into the Nashua River. Ponakin Brook and Spectacle Brook drain through the western part of the South Post south into the North Nashua River. The North Nashua River joins the Nashua River from the west approximately 2 miles south of the Post. Slate Rock Brook drains much of the central part of South Post and joins the Nashua River from the west just south of Route 2. No defined or named drainage originates in the very poorly drained flood plain of the river. Closed basins, which have no surface outlets, such as Cranberry Pond, occur within South Post.

In the Main Cantonment Area, the main surface water bodies are Mirror Lake and Little Mirror Lake, which are in closed basins, and Robbins Pond, which is drained northward by Willow Brook into Nonacoicus Brook within the North Post.

Cold Spring Brook originates on the Main Cantonment Area between Mirror Lake and Robbins Pond and flows northeast to join Bowers Brook off-post. Bowers Brook flows into Grove Pond, which flows into Plow Shop Pond adjoining the northeast edge of the Main Cantonment Area. The outlet from Plow Shop Pond is the main source for Nonacoicus Brook which flows west through the south part of North Post into the Nashua River. The North Post has no other surface streams, but surface runoff drains directly into the Nashua River.

2.1.3.1 Stratigraphy/Lithology

Five major bedrock stratigraphic units can be found on Fort Devens. Major bedrock outcrops are at the following locations: Shepley's Hill; two hills just north of Robbins Pond; a hill near Jackson Gate; and a rock quarry in the South Post, west of the Nashua River. All of the units are Paleozoic in age and range from Upper Ordovician to Devonian, and are described in detail by Goldsmith, et al., 1983. Stratigraphic unit names are from Emerson (1917), and some later authors such as Peck (1975), have proposed alternative nomenclature.



Source: Interagency Agreement USEPA / USATHAMA

Scale in miles
1 3/4 1/2 1/4 0 1

Legend

. . . . Fort Devens Boundary

Figure 2-4 SURFACE WATER HYDROLOGY OF FORT DEVENS

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Ayer Granite crops out on Shepley's Hill. It is referred to as the Devens, Long Pond Facies of the Ayer Granite. The age of the unit ranges from Upper Ordovician to Lower Silurian. The lithology is characterized as equigranular to porphyritic gneissic biotite granite and granodiorite.

The Clinton Facies of the Ayer Granite is Lower Silurian in age. Lithologically it is characterized as a porphyritic biotite granite with a non-porphyritic border phase. It intrudes into the Berwick Formation and is therefore younger.

The Berwick Formation is lower Silurian in age and is characterized as a metasediment composed of thin to thick bedded calcareous sandstones, siltstones with minor inclusions of muscovite schist and augen gneiss. It crops out on Shepley's Hill in the Main Cantonment Area.

The Oakdale Formation is Silurian, and is described as a thin-bedded pelitic and calcareous metasiltstone and muscovite schist. It crops out in the South Post area.

The Worcester Formation is Upper Silurian to Lower Devonian in age. It crops out in a quarry near the South Post artillery impact area. It is lithologically described as a carbonaceous slate and phyllite with minor inclusions of metagraywackes.

The Silurian Tower Hill Quartzite crops out east of the installation where it forms several major northeast striking ridges. Lithologically it is composed of quartzite and phyllite. Several major faults parallel outcrops of this formation.

The structural geology of Fort Devens and the surrounding area is very complex, as indicated by the outcrops of intensely folded and faulted bedrock. This is especially evident along the road near Jackson Gate on the southern corner of the Main Cantonment Area. The Bedrock Geologic Map of Massachusetts, (Goldsmith, et al., 1985), shows low-angle thrust faults along the eastern boundary of the installation. Locally, folds parallel the fault trace. This is especially evident east of the installation where outcropping of Tower Ridge Quartzite occurs. No major folds are exhibited on the surface of the installation because they are masked by the mantle of unconsolidated glacial deposits.

2.1.3.2 Soils

The soils of the Fort Devens area are described by the United States Department of Agriculture, Soils Conservation Service in the 1985, Soil Survey of Worcester County, Massachusetts, Northeastern Part.

The mapped units covering Fort Devens Military Reservation consist of associations of soil series, in three sets: the Winooski-Limerick-Saco, the Hinkley-Merrimac-Windsor, and the Paxton-Woodbridge-Canton.

The Winooski-Limerick-Saco Association is formed on the alluvium deposited by the Nashua River and the North Nashua River. The area covered by this association is covered approximately 34 percent by Winooski loams over sand (moderately well drained); 25 percent by Limerick silt loams over very fine sandy loam (poorly drained); and 16 percent by Saco silt loam, over silt-loam or very fine sandy loam (very poorly drained), in pockets or depressions along the river. The remaining 25 percent of the area consists of minor soils, among which the only poorly drained soil is Swansea muck in bogs and depressions. These soils do not underlay any of the areas of investigation.

The Paxton-Woodbridge-Canton Association is developed on glacial till and typically consists of 40 percent Paxton fine sandy loam, well drained, above a slow to very slowly draining till substratum. Eighteen percent is typically Woodbridge fine sandy loam, moderately well drained, above a slow to very slowly draining till substratum. Eight percent is typically Canton sandy loam, a moderately rapid to rapid draining soil above a friable substratum of till formed from gneiss and granite. Thirty-four percent of the association consists of minor soils, including poorly drained soils in depressions and along drainageways such as Ridgebury and Whitman organic rich loam above fine sandy loam, and Swansea muck soils in swamps and wetlands. Based on the geologic maps, none of the areas of investigation are primarily on soils of this association. Although a minor part of Shepley's Hill Landfill could be, this area being just outside the soil survey area. Canton soils would be expected above till derived from the Ayer granite.

The Hinkley-Merrimac-Windsor Association is the most important association from the point of view of the SIs, since it appears that all or almost all the areas of investigation are on these soils.

These soils are formed on water sorted deposits of glacial outwash and typically 27 percent are Hinkley loams or sandy loams, excessively drained, over sand and gravel; 20 percent are Merrimac loams or sandy loams, somewhat excessively drained, over sand and gravel; 9 percent are Windsor loamy fine sands, excessively drained, above sand; 44 percent of the soils in this association are other soils of minor extent. The only poorly drained soils are Scarboro mucky fine sandy loam over sand, in bogs and swamps, and, the Freetown muck, which is over 51 inches thick, also found in swamps.

2.2 HISTORY

Fort Devens was established in 1917 (circa World War I) as Camp Devens, a temporary training camp for soldiers from the New England area. Since that time it has been an installation of the U.S. Army

Forces Command (FORSCOM). In 1922, the camp was designated a summer training camp for several military groups, Reserve Officer Training Corps (ROTC) Cadets, and Civilian Military Training Camp Candidates. Between 1929 and 1930, it served as the location for test firing of rockets. By 1931, the camp became a permanent installation and was renamed Fort Devens. Between 1931 and 1940, Fort Devens was a training installation. From November 1940 until May 1946, Fort Devens functioned as an induction center for an estimated 650,000 military personnel during World War II. At the close of the war, Fort Devens served as a demobilization center and was subsequently placed in caretaker status. It was again used as an induction and training center during and after the Korean and Vietnam conflicts.

During Operation Desert Shield and Operation Desert Storm, Fort Devens was used as an equipment preparation and mobilization area. Subsequently, it has been used for demobilization and out-processing of equipment assigned to units throughout the New England region.

Currently, the mission of Fort Devens is to command and train its assigned units and to support the United States Army Security Agency Training Center and School, United States Army Reserves, Massachusetts National Guard, Reserve Officer Training Programs, and Air Defense sites in New England. No major industrial operations occur at Fort Devens, although several small-scale industrial operations are performed under the Directorate of Plans, Training, and Security (DPTS); the Directorate of Industrial Operations (DIO); and the Directorate of Engineering and Housing (DEH). The major waste-producing operations performed by these groups are photographic processing and maintenance of vehicles, aircraft, and small engines.

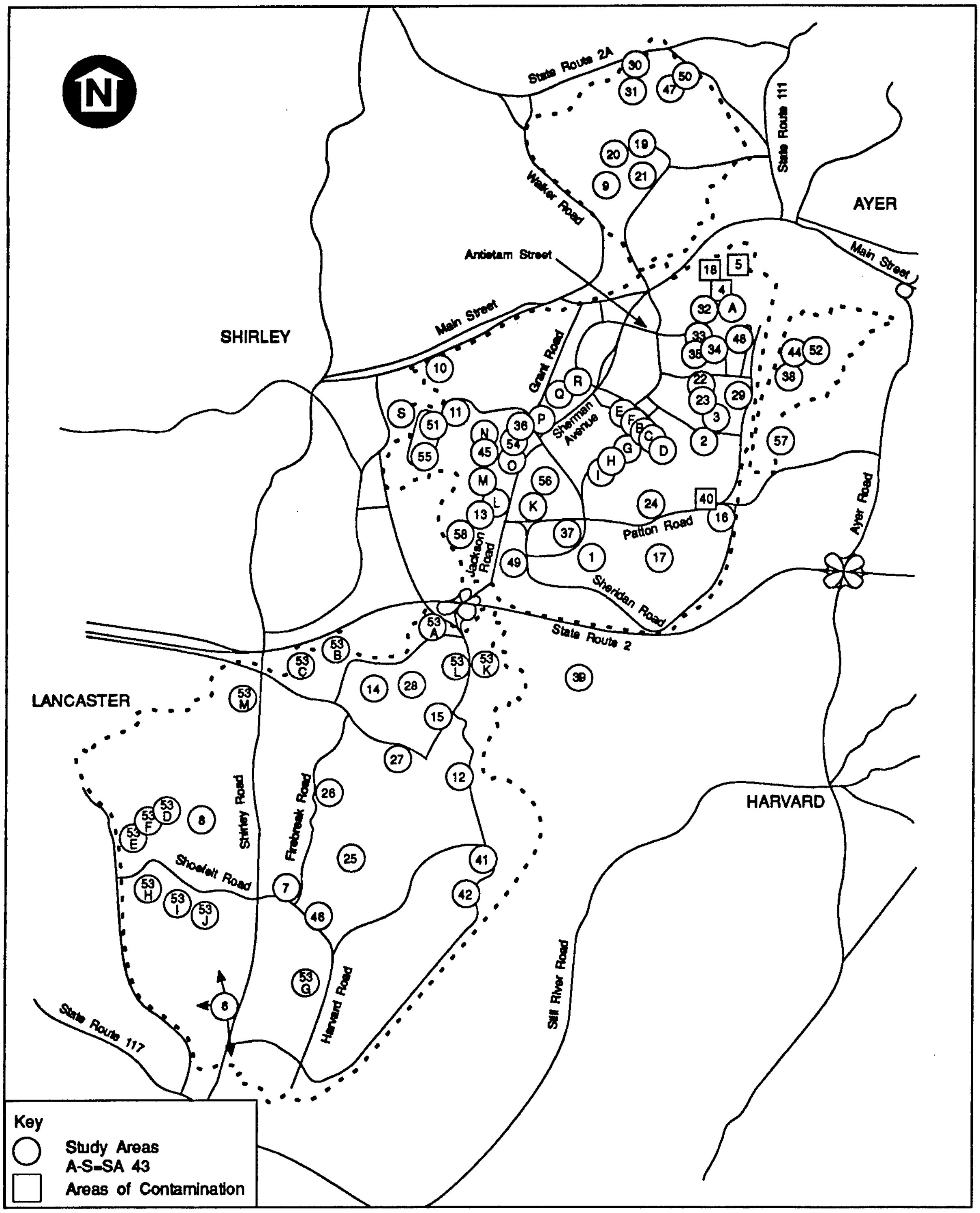
2.3 INITIAL EVALUATION OF AOCs AND SAs AT FORT DEVENS

A total of 58 AOCs and SAs have been identified at Fort Devens, each eventually slated for evaluation (Figure 2-5). The draft MEP of July 1991 lists 54 sites but Fort Devens has identified 4 new sites which will be added to the final draft version of the MEP. Under the current fiscal year budget, a total of six sites (SAs 15, 24, 25, 26, 32 and 48) will undergo an SI. Two landfills (one encompassing AOCs 4, 5, and 18, and the other, AOC 40) are simultaneously undergoing remedial investigations (RIs). Together, a total of 10 AOCs and SAs in the MEP for Fort Devens will be investigated under the task orders to E & E.

As a general background for all sites other than the RI AOCs and SI SAs listed above, the following descriptions are provided below (MEP, 1989), and a reference table is provided in Table 2-1.

SA 1 - CUTLER ARMY HOSPITAL INCINERATOR

Cutler Army Hospital uses an incinerator to destroy pharmaceutical wastes and non-hazardous medical wastes, including dirty syringes, shot needles, human body parts, and clothing and bedding used by diseased



Source: Interagency Agreement USEPA / USATHAMA

Legend

——— Road

– – – Installation Boundary

Scale in miles
1 3/4 1/2 1/4 0 1

Figure 2-5 LOCATION OF SITE INVESTIGATION SITES AT FORT DEVENS, MA

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Table 2-1

FORT DEVENS STUDY AREAS (SAs)
AND AREAS OF CONTAMINATION (AOCs)

Area	Delivery Order Requests	Site Name	Activity	Current Status	Post Location
SA 1		Cutler Army Hospital incinerator	Medical/biological wastes incinerated	Active	C
SA 2		Veterinary clinic incinerator	Medical/veternary wastes incinerated	Active	C
SA 3		Intelligence School	Classified documents incinerated	Demolished	C
AOC 4	RI	Sanitary landfill incinerator (Bldg. 38)	Household debris incinerated	Inactive	C
AOC 5	RI	Shepley's Hill Landfill (landfill No. 1)	Disposal of household refuse, construction debris, and military refuse	Active	C
SA 6		Landfill No. 2	Disposal of household refuse and glass	Inactive	S
SA 7		Landfill No. 3	Disposal of household refuse and glass	Inactive	S
SA 8		Landfill No. 4	Disposal of household refuse and military items	Inactive	S
SA 9		Landfill No. 5	Dispos1 of construction debris, tree stumps, and limbs	Inactive	C
SA 10		Landfill No. 6, near Shirley Gate	Disposal of debris from demolition of six warehouses	Inactive	C
SA 11		Landfill No. 7, near Lowell Street	Disposal of debris from demolition of hospital	Inactive	C
SA 12		Landfill No. 8	Disposal of construction and range operation debris	Inactive	S
SA 13		Landfill No. 9, near Lake George Street	Disposal of construction debris, tree stumps, and possibly oil	Inactive	C
SA 14		Landfill No. 10, (near Dixie Road)	Abandoned cars placed in quarry	Inactive	S

C = Main Cantonment Area N = North Post S = South Post Source: USATHAMA, 1991

Table 2-1 (Cont.)

FORT DEVENS STUDY AREAS (SAs) AND AREAS OF CONTAMINATION (AOCs)

Area	Delivery Order Requests	Site Name	Activity	Current Status	Post Location
SA 15	SI	Landfill No. 11, (near the helipad)	Fuel oil burned	Inactive	S
SA 16		Shoppette landfill (No. 12)	Disposal of household rubbish	Inactive	C
SA 17		Little Mirror Lake (landfill No. 13)	WW II grenades placed in the lake	Inactive	C
AOC 18	RI	Asbestos cell (Part of Shepley's Hill Landfill (SAS)	Disposal of asbestos and asbestos containing debris	Active	C
SA 19		Wastewater treatment plant	Treatment of sanitary sewage, floor drainage, wash rack discharge, boiler blowdown, swimming pool water, filter backwash	Active	N
SA 20		Rapid infiltration basins	Treatment of WWTP effluent	Active	N
SA 21		Sludge drying beds	Application of sludge from WWTP Imhoff tanks	Active	N
SA 22		Hazardous waste storage facility (Bldg. 1650)	RCRA Part B permitted storage of hazardous waste	Active	C
SA 23		Paper recycling center (Bldg. 1650)	Storage and transfer facility for recycle paper	Inactive	C
SA 24	SI	Waste explosives storage bunker 187 (Bldg. 3644)	Storage of waste explosives from both military and civilian sources	Active	C
SA 25	SI	Waste explosives detonation range (EOD range)	Destruction of various explosives stored in bunker 187	Active	S
SA 26	SI	Waste explosive detonation range (Zulu I and II)	Training area/hand grenade range, open burning of explosives	Active	S

C = Main Cantonment Area N = North Post S = South Post Source: USATHAMA, 1991

Table 2-1 (Cont.)

FORT DEVENS STUDY AREAS (SAs)
AND AREAS OF CONTAMINATION (AOCs)

Area	Delivery Order Requests	Site Name	Activity	Current Status	Post Location
SA 27		Waste explosives detonation range (Hotel)	Training area	Active	S
SA 28		Waste explosives detonation range (training area 14)	Training area	Inactive	S
SA 29		Transformer storage area at the DEH yard (Bldg. 1438)	Storage of out-of-service transformers prior to disposal	Active	C
SA 30		Moore Army Airfield drum storage area	90-day accumulation of hazardous waste	Active	N
SA 31		Moore Army Airfield firefighting training area	Burning of jet fuel and solvents for training	Inactive	N
SA 32	SI	DRMO yard (Bldg. 204)	Storage of scrap metal, drained batteries, tires, and used office equiipment	Active	C
SA 33		DEH entomology shop (Bldg. 262)	Storage and mixing of pesticides and herbicides	Active	C
SA 34		Former DEH entomology shop (Bldg. 245)	Storage and mixing of pesticides and herbicides	Inactive	C
SA 35		Former DEH entomology shop (Bldg. 245)	Storage and mixing of pesticides and herbicides	Inactive	C
SA 36		Former DEH entomology shop (Bldg. 2728)	Storage and mixing of pesticides and herbicides	Inactive	C
SA 37		Golf course entomology shop (Bldg. 3622)	Short-term storage of pesticides	Active	C
SA 38		Battery repair area (Bldg. 3713)	Batter acid neutralized	Inactive	C
SA 39		Transformer near Bldg. 4250	Leak from PCBC-contaminated transformer	Inactive	C

C = Main Cantonment Area N = North Post S = South Post Source: USATHAMA, 1991

Table 2-1 (Cont.)

FORT DEVENS STUDY AREAS (SAs) AND AREAS OF CONTAMINATION (AOCs)

Area	Delivery Order Requests	Site Name	Activity	Current Status	Post Location
AOC 40	RI	Cold Spring Brook Landfill	Disposal of construction debris and unmarked drums	Inactive	C
SA 41		Unauthorized dumping area (site A)	Disposal of unknown materials	Unknown	C
SA 42		Popping furnace	Incineration fo small-arms ammunition	Inactive	S
SA 43		Historic gas station sites (19 sites designated A-S)	Gasoline storage and distribution	Inactive	C
SA 44		Cannibalization yard (Bldg. 3713)	Vehicle storage prior to disassembly for parts	Active	C
SA 45		Wash rack at Lake George Street	Possible private vehicle maintenance	Active	C
SA 46		Training area 6d	Disposal of unknown materials	Unknown	S
SA 47		MAAF LUST site (Bldg. 3816)	Diesel fuel handling and storage	Inactive	N
SA 48	SI	Bldg. 202 LUST site	Fuel handling and storage	Inactive	C
SA 49		Bldg. 3602 LUST site	Fuel handling and storage	Inactive	C
SA 50		MAFF WWII fuel point	Fuel Storage	Inactive	N
SA 51		O'Neil Bldg. spill site	Diesel fuel handling and storage	Active	C
SA 52		MMD maintenance yard	Vehicles with significant leaks stored for repairs	Active	C
SA 53		South post POL spill areas	Fuel handling and temporary storage	Active	S
SA 54		Bldg. 2680	Gasoline storage and distribution	Inactive	C
SA 55		Shirley Housing Area Trailer Park Fuel Tanks	Heating oil storage tanks	Inactive	C

C = Main Cantonment Area N = North Post S = South Post Source: USATHAMA, 1991

Table 2-1 (Cont.)

FORT DEVENS STUDY AREAS (SAs) AND AREAS OF CONTAMINATION (AOCs)

Area	Delivery Order Requests	Site Name	Activity	Current Status	Post Location
SA 56		Bldg. 2417 LUST Site	Fuel oil handling and storage.	Inactive	C
SA 57		Bldg. 3713 Fuel Oil Spill Site	Fuel oil handling and storage.	Active	C
SA 58		Buildings 2648 and 2650 Fuel Oil Spills	Fuel oil handling and storage	Inactive	C

C = Main Cantonment Area N = North Post S = South Post Source: USATHAMA, 1991

patients. The incinerator ash is placed into garbage cans, and then thrown into a covered dumpster; when the dumpster is full it is taken to Shepley's Hill Landfill. The physical condition of the incinerator was reported to be poor (e.g., gaskets are missing, firebrick cracked in many places). Ash samples analyzed to determine extraction procedure (EP) toxicity showed that one out of five violated the (5.0 mg/l) criterion for lead. This site is not part of this delivery order but is slated for SI activities in the future.

SA 2 - VETERINARY CLINIC INCINERATOR

The veterinary clinic also maintained an incinerator, primarily to destroy animal carcasses, although it is also used to burn classified materials, needles, medical or veterinary wastes, and expired drugs. Occasionally, the incinerator is used to burn photographs and paper, as well as medical and pharmaceutical wastes from the Cutler Army Hospital when its incinerator (SA 1) is shut down. The ash from the incinerator is normally bagged in plastic bags and sent to Shepley's Hill Landfill. Operational problems have been noted, including the overall integrity of the incinerator. Tests for EP toxicity for metals on the ash have been negative. This site is not part of this delivery order but operational and ash tests are recommended for investigation.

SA 3 - INTELLIGENCE SCHOOL INCINERATOR

The Intelligence School Incinerator was used from 1971 until 1976 to burn paper. In 1976, the incinerator was closed by the State of Massachusetts for exceeding capacity standards, and has not been used since. The incinerator is very rusty and all of the gaskets have deteriorated. This site is not part of this delivery order but is slated for SI activities in the future.

AOC 4 - SHEPLEY'S HILL LANDFILL INCINERATOR

The Shepley's Hill Landfill incinerator was located in former Building 38, which was built in 1941 at what is now the middle of Shepley's Hill Landfill. The incinerator operated until the late 1940s and burned household debris generated by the Fort. The residual glass and incinerator ash were placed in a landfill next to the building. In September 1967, the incinerator was demolished and the rubble placed in Shepley's Hill Landfill (AOC 5). This site is part of this delivery order under the Shepley's Hill Landfill RI.

AOCs 5 AND 18 - SHEPLEY'S HILL LANDFILL (NO. 1) AND ASBESTOS CELL

The Shepley's Hill Landfill, begun in 1917, is about 84 acres in size and is located in the northeastern portion of the Main Cantonment Area, which was formerly a wetland area. Currently, the landfill receives about 6,500 tons per year of household refuse, military refuse, and construction debris. The landfill is operated using the modified trench method, with a total depth of about 30 feet. The landfill also contains a permitted asbestos cell; an estimated 6.6 tons of asbestos was placed in the cell between March 1982 and November 1985. The cell is located in Section A of the Phase IV area of the landfill.

Starting in 1986, the landfill is being closed in phases with the final phase scheduled for closure this year. This site is part of this delivery order under the Shepley's Hill Landfill RI.

SA 6 - LANDFILL NO. 2

Landfill No. 2 is thought to have been a town dump used by local residents for disposal of household rubbish and glass, from about 1850 to 1920, prior to the site's incorporation into Fort Devens. The existence and location of the inactive Landfill No. 2 has not been verified. The exact size of the landfill is unknown, but it has been reported to have been about 1 acre in extent and has not received any debris for over 71 years. This site is not part of this delivery order but is slated for SI activity in the future.

SA 7 - LANDFILL NO. 3

Landfill No. 3 is reported to have been an undocumented estate or farm dump where household rubbish and glass were disposed of from the mid 1800s to about 1920. The landfill, which cannot be found, is reported to have been located in the middle of the South Post. The site is reported to be about 1 acre in extent and has not received any debris for over 71 years. This site is not part of this delivery order but is slated for SI activity in the future.

SA 8 - LANDFILL NO. 4

The exact location of Landfill No. 4 is unknown. The landfill reportedly was used from about 1900 to 1930 for the disposal of household and military items prior to and after the land was incorporated into Fort Devens. It is reported to have been about 6 acres is size and located in the south-central part of the South Post. This site, if it exists, has not received any debris for nearly 61 years. This site is not part of this delivery order but is slated for SI activity in the future.

SA 9 - LANDFILL NO. 5

Landfill No. 5 is located south of the wastewater treatment plant (WWTP) in the North Post; it occupies 14.8 acres. The landfill is an old dump used primarily for construction debris, junked cars, and tree stumps. It operated from the late 1950s until 1978, when it was closed. Originally, this site was a low wet area, but the ground level has been raised by 30 to 40 feet. Access was not controlled during the period when the dump was operated; it is not known to what extent unauthorized dumping has occurred. The presence or extent of contamination at this site is not known. This site is not part of this delivery order but is slated for SI activity in the future.

SA 10 - LANDFILL NO. 6

Landfill No. 6 was reported to be a trench that received debris from demolition of six warehouses that were demolished between 1975 and 1980. The exact location of the landfill is unknown. This site is not part of this delivery order but is slated for SI activity in the future.

SA 11 - LANDFILL NO. 7

Landfill No. 7, located just east of Lovell Street in the Main Cantonment Area, was active from 1975 to 1980. The site, about 2 acres in extent, was part of a small gully leading down, approximately 200 feet, to the Nashua River. During the time the site was active, it received wood-frame hospital demolition debris. The landfill was covered and graded after closure. In November 1988, it was observed that during construction of the new intelligence school building and parking lots, the landfill had been disturbed and old construction material left on its surface. This site is not part of this delivery order but is slated for SI activity in the future.

SA 12 - LANDFILL NO. 8

Landfill No. 8, located across from the combat pistol range, consists of debris randomly dumped without supervision over the edge of a 30-foot hill. Although the dump has been reported to be in operation from 1960 to the present, the site appears to be inactive. Material disposed of at this site consisted of concrete blocks, barbed wire, old stumps, tree cuttings, brush, wood, and other inert materials. This site is not part of this delivery order but is slated for SI activity in the future.

SA 13 - LANDFILL NO. 9

Landfill No. 9 is reported to have been used from 1965 to 1970 for the disposal of construction debris, tree trunks, stumps, and possibly waste oil. The exact location of the 1-acre site is not known because upon closure it apparently was covered. The only evidence of a landfill is a miscellaneous mixture of wood, metal objects, cans, and other debris scattered about on the surface of a small gully that leads down to the Nashua River, about 2,100 feet to the west. This site is not part of this delivery order but is slated for SI activity in the future.

SA 14 - LANDFILL NO. 10

This landfill is actually an abandoned quarry, about 1 acre in size, into which unwanted automobiles are illegally disposed. No records are available concerning the number of cars disposed of at this site. No contamination is apparent and all the automobiles reportedly have been removed, but there is a potential for the presence of gasoline and oil. The quarry is very deep, making exact determinations of remaining waste difficult. This site is not part of this delivery order but is slated for SI activity in the future.

SA 15 - LANDFILL NO. 11

This site is scheduled for detailed SI work under this delivery order and is described in Section 3.1.

SA 16 - SHOPPETTE LANDFILL (NO. 12)

A small landfill, about 1 acre in size, was operated for 3 weeks in 1985 to reduce the volume of material entering Shepley's Hill Landfill, which had limited availability due to a fire. It received construction debris generated at the installation. No surface evidence is visible to attest to the landfill's prior existence. The landfill's location was observed to be in the Main Cantonment Area southeast of the Shoppette. This site is not part of this delivery order but is slated for SI activity in the future.

SA 17 - LITTLE MIRROR LAKE (LANDFILL NO. 13)

Little Mirror Lake is in the southeastern portion of the Main Cantonment Area near the enlisted housing area. The Mirror Lake area is a major wetland. At an unknown time, World War II-era grenades were disposed of in Little Mirror Lake. During a low-water period in the early 1970s, about 200 grenades were exposed. They were removed and destroyed. Little information exists regarding the removal action or the exact location where the grenades were found. This site is not part of this delivery order but is slated for SI activity in the future.

SAs 19, 20, 21 - WASTEWATER TREATMENT PLANT (WWTP), RAPID INFILTRATION BEDS, AND SLUDGE DRYING BEDS

The WWTP, formerly called the sewage treatment plant, is located in the North Post and was built in 1942. In 1985, the WWTP served an effective population of about 11,000 people. The facility does not require a National Pollutant Discharge Elimination System (NPDES) permit since it does not discharge to surface waters. The major operational problem noted at the WWTP has been the maintenance of the distribution troughs in the infiltration sand beds and their role in the removal of nitrogen (the beds were not designed for the removal of nitrogen). The rapid infiltration basins are less than 1,200 feet, up gradient, from the Nashua River. Samples taken from monitoring wells surrounding the basins show that nitrate levels exceed standards set for groundwater quality. It is not known whether the nitrate source is the infiltration beds, sludge beds, or both. This site is not part of this delivery order but is slated for SI activity in the future.

SA 22 - HAZARDOUS WASTE STORAGE FACILITY AT BUILDING 1650

This site is not slated for SI activity in the future. See Section 2.4, SAs Requiring No Further Action.

SA 23 - PAPER RECYCLING CENTER (BUILDING 1650)

This site is not slated for SI activity in the future. See Section 2.4, SAs Requiring No Further Action.

SA 24 - WASTE EXPLOSIVES STORAGE BUNKER 187 (BUILDING 3644)

This site is scheduled for detailed SI work under this delivery order and is described in Section 3.2

SA 25 - EOD RANGE

This site is scheduled for detailed SI work under this delivery order and is described in Section 3.3.

SA 26 - ZULU RANGE

This site is scheduled for detailed SI work under this delivery order and is described in Section 3.4.

SA 27 - WASTE EXPLOSIVES DETONATION RANGE (HOTEL)

Hotel range is about 7 acres in size and is located on the northwestern edge of the artillery area, about 500 yards west of Cranberry Pond. Hotel is a training range used for firing several types of rifle grenades and 20-millimeter automatic cannons with red phosphorus tracers. Prior to 1979, this range was used for explosive ordnance disposal of old or defective high-explosive grenades and 3.5-millimeter rocket projectiles. This site is not part of this delivery order but is slated for SI activity in the future.

SA 28 - WASTE EXPLOSIVES DETONATION RANGE (TRAINING AREA 14)

This 160-acre training area in the South Post contains a helipad; a jump tower; pistol, 81-millimeter mortar, and night fire/rifle ranges; and SA 15. The range currently is a tactical training area in constant use by active and reserve component units. In the 1940s, a 6-acre hand grenade range was established on the northern side of the range. In the 1970s, this grenade range was moved and converted to a medical litter obstacle course. Since being converted, no hazards have been reported at SA 28. This site is not part of this delivery order but is slated for SI activity in the future.

SA 29 - TRANSFORMER STORAGE AREA AT THE DEH YARD (BUILDING 1438)

The transformer storage area has been in use since 1980. It has a roof and paved floor and is enclosed on three sides. About 33 square feet are bermed for temporary storage of polychlorinated biphenyls (PCB) transformers. A second storage yard was in use in 1988. This area was unprotected, unpaved, and 14 PCB-contaminated transformers are located there. The transformer storage area showed no signs of spills or leaks. There were also no reported spills or releases in the yard storage area where transformers were stored temporarily. However, the potential exists for present or future leaks. This site is not part of this delivery order but is slated for SI activity in the future.

SA 30 - MOORE ARMY AIRFIELD DRUM STORAGE AREA

The temporary drum storage area at Moore Army Airfield was an outdoor temporary satellite accumulation point for storage of containerized hazardous waste for 90 days or less. This storage area was reportedly used from 1975 to 1990. The temporary storage location was not bermed or sheltered. The asphalt storage pad has several cracks, and leaks were apparent on the soil and asphalt surface during a 1988 site audit. The Nashua River lies in the valley below the site. This site is not part of this delivery order but is slated for SI activity in the future.

SA 31 - MOORE ARMY AIRFIELD FIRE-FIGHTING TRAINING AREA

The fire-fighting training pit, used between 1975 and 1986, is located on an asphalt-covered concrete pad and surrounded by a wide earthen berm. Fuels used during training included contaminated fuel and paint thinner. The concrete pad is reported to have cracked due to age; however, no discharge of fuel from the training pit has been reported.

This site is not part of this delivery order but is slated for SI activity in the future.

SA 32 - DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO) YARD

This site is scheduled for detailed SI work under this delivery order and is described in Section 3.5.

SA 33 - DEH ENTOMOLOGY SHOP (BUILDING 262)

Pesticides and herbicides have been used at Fort Devens for general pest control and elimination of weeds in areas around the base. Building 262 is currently used both for pesticide storage and mixing. Very little documentation exists relating to contamination associated with pesticides at SA 33. Housekeeping in and around the building was reported to be lax during a 1988 audit. This site is not part of this delivery order but is slated for SI activity in the future.

SA 34 - FORMER DEH ENTOMOLOGY SHOP AT BUILDING 245

Pesticides were formerly stored and mixed in Building 245 during the period 1978 to 1982. The building is currently used to store cleaning solutions. The facility has a history of small rinse-water discharges and small spills into the sanitary sewer system. A drain pipe was observed in 1988, leading directly from a sink to the ground immediately outside the building. Overall housekeeping at this time was poor. This site is not part of this delivery order but is slated for SI activity in the future.

SA 35 - FORMER DEH ENTOMOLOGY SHOP (BUILDING 254)

The Former DEH Entomology Shop was used for pesticide storage and control during the period 1978 to 1982. This facility, which was used to store pesticides such as Malathion, Diazinon, VG Trol, and Weedier, did not meet Environmental Protection Agency (EPA) guidelines. The building is still used primarily to store general equipment and dry cleaning solvents. The facility has a history of small rinse-water discharges and small spills into the sanitary sewer system. Housekeeping at the facility is poor. This site is not part of this delivery order but is slated for SI activity in the future.

SA 36 - FORMER DEH ENTOMOLOGY SHOP (BUILDING 2728)

The Former DEH Entomology Shop was used for pesticide storage and control during the period 1968 to 1978. This facility, which was used to store pesticides and herbicides such as Diazinon, Baygone, and Dursban, did not meet EPA guidelines. The building is now used for storage of cars, trucks, and plows. The facility has a history of small rinse-water discharges and small spills into the sanitary sewer system. No visible evidence of pesticide or herbicide contamination was evident during a site visit in 1988. This site is not part of this delivery order but is slated for SI activity in the future.

SA 37 - GOLF COURSE ENTOMOLOGY SHOP (BUILDING 3622)

The Golf Course Entomology Shop has been used for pesticide storage and mixing since 1976. The building contains pesticides used on the golf course. No more than a 1-week supply of pesticides has been stored in the building at any one time. A 1985 assessment by the U.S. Army Environmental Hygiene Agency (USAEHA) noted many inadequacies related to the building's current use, and that it did not meet EPA guidelines for pesticide storage. This site is not part of this delivery order but is slated for SI activity in the future.

SA 38 - BATTERY REPAIR AREA (BUILDING 3713)

One of the DIO Maintenance Division industrial operations conducted in Building 3713 includes battery repair, which generates about 106 gallons of waste battery acid each month. Waste acid is stored in federally approved containers and later taken to the DEH hazardous waste storage area. Prior to 1978, waste electrolyte was placed in a pit east of Building 3713 and neutralized with sodium bicarbonate. It was reported that the pit was covered and paved over in 1981. From 1978 to August 1980, the waste battery acid was neutralized in a large tank and discharged to the sewer system. There are no reports of contaminated surface soil or water around the site. This site is not part of this delivery order but is slated for SI activity in the future.

SA 39 - TRANSFORMER NEAR BUILDING 4250 (OLD SYLVANIA BUILDINGS)

The Old Sylvania Buildings are locations within what is now the Oxbow National Wildlife Refuge. According to available information, two types of removal actions were taken at this site: removal of three USTs and removal of oil that is believed to have leaked from a transformer. In September 1984, a spill area was discovered near Building 4250. A spill report documents the cleanup action taken for the stained soil. This site is not part of this delivery order but is slated for SI activity in the future.

AOC 40 - COLD SPRING BROOK LANDFILL

The Cold Spring Brook Landfill is located near the Shoppette on Patton Road. It is considered an abandoned landfill and became of concern in November 1987 when 14 reused 55-gallon drums were found along Cold Spring Brook. Wastes included concrete slabs, wire, tanks, rubber, timber, and debris found at depths between 10 and 25 feet. Water, surface water, sediment, and soil samples that were taken in 1988 showed elevated levels of volatiles and metals. This site is scheduled for detailed RI work under this delivery order and is discussed in the RI work plan under a separate cover.

SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

This old landfill, about 1 acre in size, located near a wetland, is completely overgrown with trees and vegetation, and no records are available detailing when the site was used or what material was placed in it. It appears that the site was used up to the 1950s for disposal of non-explosive military and household debris. This site is not part of this delivery order but is slated for SI activity in the future.

SA 42 - POPPING FURNACE

The popping furnace, which does not appear to have been used since World War II, is located across from the "O" Range on the South Post. The site history is largely unknown. The site consists of an old furnace in which small caliber ammunition apparently was burned. Waste material (ash and casings) may have been thrown down a 30-foot hillside on the site. There are no records of any hazardous materials or wastes being dumped at this site. This site is not part of this delivery order but is slated for SI activity in the future.

SA 43 - HISTORIC GAS STATION SITES

The only available documentation for these sites is a map that shows the location of 17 former gasoline dispensing stations and 1 central distribution station in the current Main Cantonment Area. Figure 2-4 shows 19 sites under SA 43 and are listed A-S. The legend of the 1941 map indicates that all the USTs were 5,000 gallons with two different types of connections to the pumps. The central dispensing station appears to have been located near the current landfill and the DRMO. The length of time that these sites were in operation is not known. According to available information, it is unlikely that many of the tanks have been removed. These sites are not part of this delivery order but are slated for SIs in the future.

SA 44 - CANNIBALIZATION YARD (BUILDING 3713)

The cannibalization yard is the site of an ongoing operation in an unpaved area east of Building 3713 where vehicles are stored prior to dismantling for reusable parts. According to site personnel, the topsoil is removed periodically. The yard is not paved or bermed in any way. This site is not part of this delivery order but is slated for SI activity in the future.

SA 45 - WASH RACK AT LAKE GEORGE STREET

A vehicle wash rack along Lake George Street is an open, asphalt-paved area with eight bays for washing privately owned autos. The bays contain drains that empty into an adjacent sump or the sewer. Access to the site is open and activities are not controlled. The potential for unauthorized discharges from this site should be scrutinized carefully. This site is not part of this delivery order but is slated for SI activity in the future.

SA 46 - TRAINING AREA 6D

Training Area 6D is on the southwestern boundary of the artillery area in the South Post. It is a small sandy area that contains two abandoned armored tanks and an abundance of spent canisters that appear to have contained tear gas. Very little is known about the activities at this site. There are no visibly stained areas. This site is not part of this delivery order but is slated for SI activity in the future.

SA 47 - MOORE ARMY AIRFIELD (MAAF) UST Site (BUILDING 3816, MOGAS GENERATOR AT TOWER)

The MAAF UST site is the location of a 500-gallon diesel UST that was used to support the airfield's emergency generator that operated between 1970 and 1989. The tank was found to be leaking during construction of a generator replacement project in January 1989. Approximately 15 cubic yards of soil have been excavated. Site excavation led to discovery of other contamination suspected to be related to another unknown source. This site is not part of this delivery order but is slated for SI activity in the future.

SA 48 - BUILDING 202 UST SITE

This site is scheduled for detailed SI activity under this delivery order and is described in Section 3.6.

SA 49 - BUILDING 3602 UST SITE

Building 3602 is the location of the former motor pool fueling point where two 5,000 gallon tanks were located and believed to have leaked. The date of operation for the tanks is reported to fall between 1942 and 1975. The tanks were used in the later years for fuel oil storage. A problem with the tanks was discovered in December 1989 when field investigators working under the Abandoned UST Removal Contract (EQ-19175-8P) encountered contamination. To date, about 150 cubic yards of contaminated soil has been excavated and four test borings/wells have been drilled to bracket the area. It appears that the contamination has not traveled beyond 100 feet from the tank excavation. This site is not part of this delivery order but is slated for SI activity in the future.

SA 50 - MAAF WORLD WAR II FUEL POINT (ADJACENT TO THE EAST-WEST RUNWAY)

The MAAF WW II Fuel Point was operational between 1941 and 1945 and contains an estimated four fuel points with USTs. The abandoned tanks were discovered around 1988 and to date no action has been taken on them. MAAF staff indicated that the tanks might have been abandoned full of fuel. The precise location of the tanks is unknown. This site is not part of this delivery order but is slated for SI activity in the future.

SA 51 - O'NEIL BUILDING SPILL SITE

The O'Neil Building area is used for high frequency radio training, using diesel powered electrical generators. The generators require daily filling and draining off of water from the fuel tank. The spill incident involved leaving the drain valve open when filling, causing 15 gallons of fuel to leak onto the ground. When the spill was further investigated, it was determined that the quantity of contamination found was greater than 15 gallons, indicating a prior long-term problem as opposed to a single spill incident. Response action included removal of 200 cubic yards of soil, with significant contamination remaining. Analysis of holes after excavation reveals contamination levels ranging from 90 parts per million (ppm) to 2,500 ppm. Similar contamination is expected to exist at other pads in the same area. This site is not part of this delivery order but is slated for SI activity in the future.

SA 52 - MATERIALS MAINTENANCE DIVISION (MMD) CLASS III LEAK STORAGE YARD

The MMD maintenance yard is used as a storage area for vehicles with significant oil leaks prior to repair. Multiple small patches of visible contamination can be located on the ground, with the average patch being 2 to 3 feet in diameter. The primary contaminant is motor oil or hydraulic fluid. This area has been used since the construction of the TDA. No action has been taken to date, no testing or work has been conducted to quantify the problem. This site is not part of this delivery order but is slated for SI activity in the future.

SA 53 - SOUTH POST PETROLEUM, OIL, AND LUBRICANTS (POL) SPILL AREA

The South Post POL spill areas cover unspecified areas around the South Post where fueling/POL storage takes place during troop exercises. Figure 2-4 locates 17 spill areas (A-M) under SA 53. Many of the areas are of limited contamination, primarily consisting of vehicle fuel and oils. No action to date has been conducted to quantify or estimate the scope of contamination. This site is not part of this delivery order but is slated for SI activity in the future.

SA 54 - BUILDING 2680 UST SITE

This former motor pool fueling point, operational between the years of 1942 and 1975, was discovered to be contaminating soil in December 1989 by field investigators under the Abandoned UST Removal Contract (EQ 19175-8P). The source of the contamination was two 5,000-gallon tanks last used to store fuel oil. In response to the finding, 100 cubic yards of contaminated soil was excavated. This site is not part of this delivery order but is slated for SI activity in the future.

SA 55 - SHIRLEY HOUSING AREA TRAILER PARK FUEL TANKS

The trailer park includes 30 privately-owned trailers on government land. Each trailer includes a 225 gallon fuel oil tank located underground. The tanks are no longer used. To date, 24 tanks have been pumped. Tanks are to be removed. This site is not part of this delivery order and needs to be added to the revised MEP.

SA 56 - BUILDING 2417 FUEL OIL SPILL

A 1,000-gallon underground fuel oil tank was removed from the southwest side of Building 2417. Contamination was excavated to the building and to the road. Full remediation of the site has been prevented due to the building and a water main. The excavation is still open. This site is not part of this delivery order but has been recommended for interim action.

SA 57 - BUILDING 3713 FUEL OIL SPILL

Building 3713 is the location of several industrial activities, including a heavy duty repair shop for large Army vehicles such as tanks. A spill of fuel oil occurred in 1978 from overfilling a 30,000-gallon underground storage tank. Cleanup of the site occurred to some extent. No action to date has been conducted to quantify the extent of contamination. This site is not part of this delivery order.

SA 58 - BUILDING 2648/2650 FUEL OIL SPILLS

These buildings were used for storage and, in the process of demolishing the buildings, their fuel oil tanks were removed. Samples of the soil from the excavation indicate both fuel tanks leaked. Materials have been excavated and the pits have been left open. No further action taken to date. These sites are not part of this delivery order.

2.4 SAs REQUIRING NO FURTHER ACTION

Two of the SAs listed in the MEP have been determined not to warrant further investigation since no releases of hazardous materials to the environment can be associated with these sites. The two sites are described below.

SA 22 - HAZARDOUS WASTE STORAGE FACILITY AT BUILDING 1650

The hazardous waste storage facility is in the northeastern area of the Main Cantonment Area. It has been a storage facility since 1980, and was remodeled in 1984 to meet requirements as a Resource Conservation and Recovery Act (RCRA) Part B permitted facility. Wastes are stored inside, on cement floors equipped with bermed storage areas. No spills or releases from this facility have been reported; no visible staining or other indication of spills or leaks were evident on a walk-through in 1988. This site is not slated for future SI activity.

SA 23 - PAPER RECYCLING CENTER (BUILDING 1650)

The paper recycling center was located in Building 1650, until the hazardous waste storage facility was relocated to the building. The period of operation was April 1984 until 1985. Operations were restricted to storage and recycling of several types of paper. There is no record of any associated liquids or releases that would endanger human health or the environment. This site is not slated for future SI activity.

3. SITE LOCATIONS, BACKGROUND, AND HISTORY

E & E will conduct SIs at six SAs:

- SA 15 at Landfill No. 11,
- SA 24 at Waste Explosives Storage Bunker 187 (Building 3644),
- SA 25 at the Waste Explosive Ordnance Demolition (EOD) Range,
- SA 26 at the Waste Explosive Detonation Range (Zulu 1 and 2),
- SA 32 at the Defense Reutilization and Marketing Office (DRMO), and
- SA 48 at Building 202.

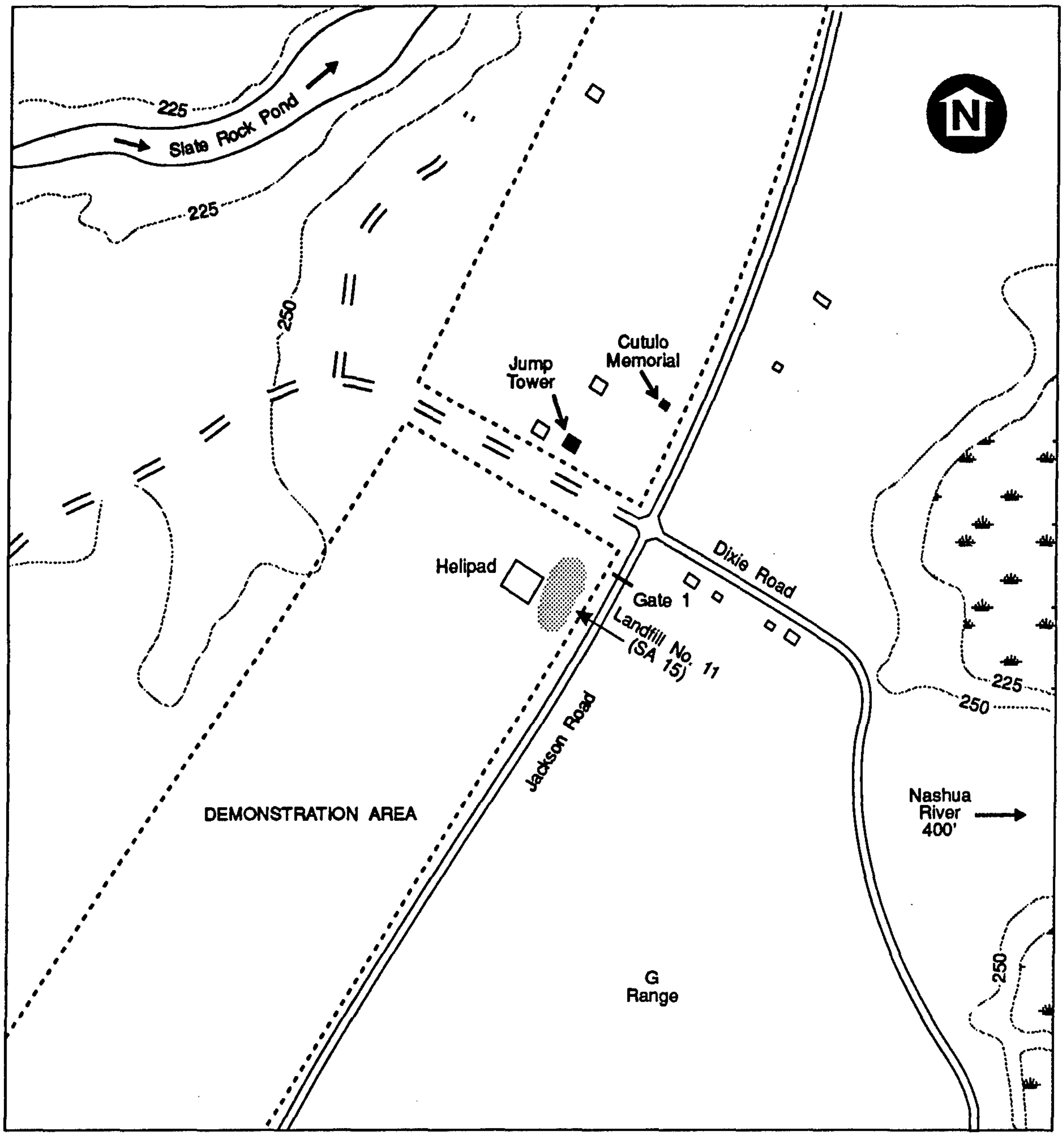
Background on each of these SA locations is described below.

3.1 SA 15 (LANDFILL NO. 11)

Landfill No. 11 is located in the South Post firing range (Figure 3-1), and reportedly consists of a series of pits in which fuel oil (primarily heavy oil No. 4 and No. 6) was burned in the mid-1960s. While active (1963 to 1966), the site encompassed about 3 acres and was located adjacent to the helipad on Jackson Road in the South Post. The pits have been filled in and there is no visible evidence of their exact location. A past investigation at the site indicated that the soil was contaminated with a POL product (Gates, 1989). However, the exact location of the pits was not identified from this investigation. Slate Rock Pond, Cranberry Pond, and the boundary of the Oxbow National Wildlife Refuge are located within 1/2 mile of the site. The area is currently the site of a communication experiment and is crisscrossed with ground antenna wires.

During the site visit, there was no evidence of past disposal activities. SI tasks at this site will focus on finding verifiable evidence of the exact location of the pits in order to permit sampling of the waste. No water wells are known to be close to the site, although base water supply well D-1 is more than 3,000 feet southeast of the site along Dixie Road at Building 4322.

Landfill No. 11 is situated above a flat-topped glacial delta deposit of sandy glacial outwash material, resulting in well-drained to excessively drained soils. Because of the excellent drainage of the soils and the very low slopes, surface drainageways have not developed. The nearest locations for potential discharge of groundwater from under the site are Slate Rock Pond, approximately 1,200 feet to the northwest, at an elevation of 220 feet above mean sea level, and the Oxbow National Wildlife Refuge, whose western edge is approximately the same distance and at about the same elevation.



Source: Fort Devens, COE, NY, DWG, 18-02-15/16, 1988

Legend

Building, Permanent

Building, Temporary

Road, Surfaced

Road, Unimproved

275 Contour

Location of SA from MEP

Wetland

Scale in Feet
0 100 200 300 400 800

Figure 3-1 ILLUSTRATION OF STUDY AREA 15 (LANDFILL NUMBER 11)

004091I.CDR

The primary concern at this site is the potential for groundwater contamination and its migration to wetlands close to the site. To establish this potential it is first necessary to define the extent and type of waste disposed of at the site.

3.2 SA 24 WASTE EXPLOSIVES STORAGE BUNKER 187 (BUILDING 3644)

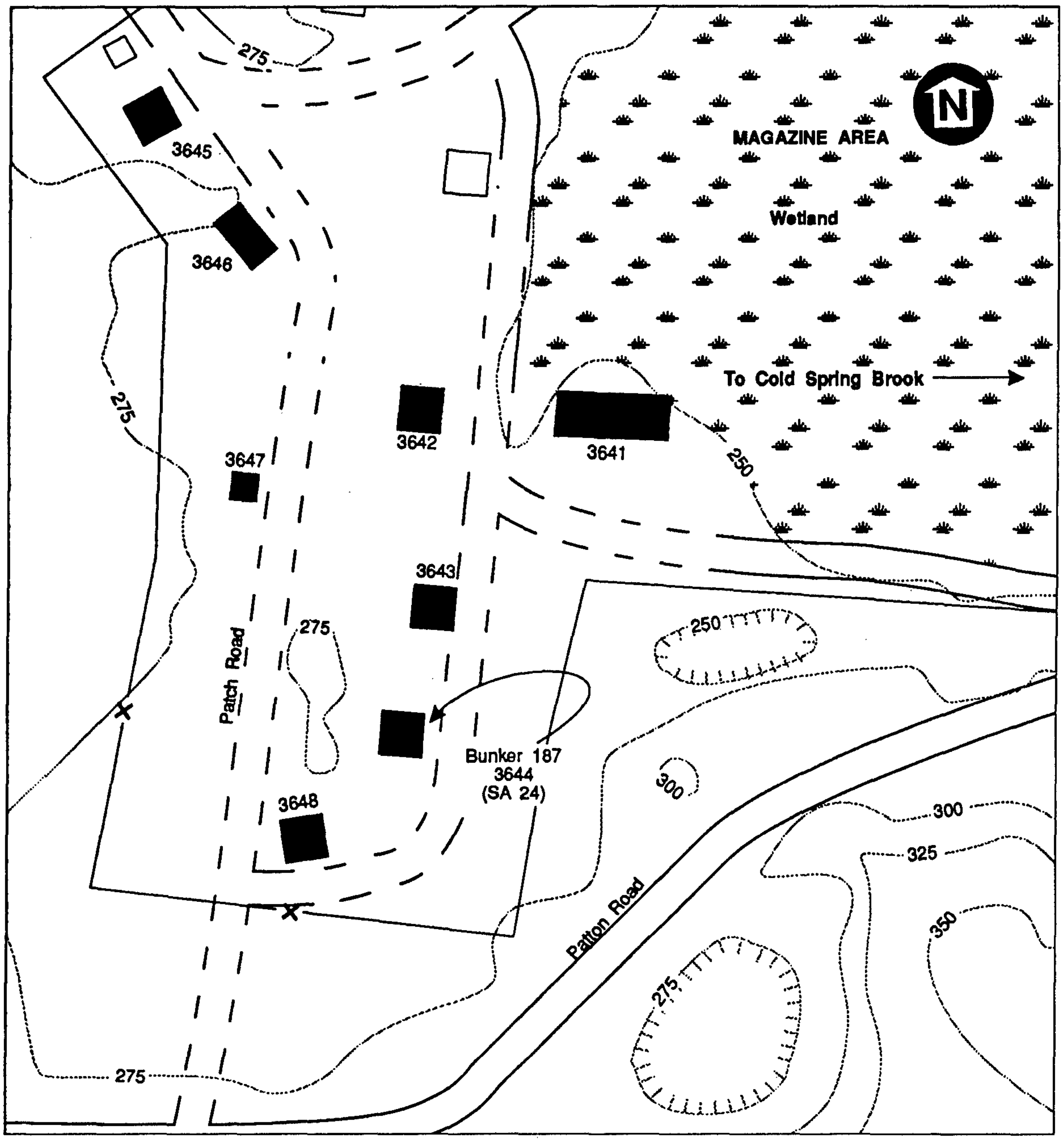
The magazine area is in the southeastern portion of the Main Cantonment Area (Figure 3-2). Waste Explosives Storage Bunker 187 is in the magazine area, which requires a prearranged security pass. The bunker is a small fortified quonset hut with cement floors and has been used since 1979. Explosives that are designated for detonation at the EOD range are stored in the bunker.

The bunker is situated on a flat-topped hill or terrace of poorly sorted sands, silts, clays, gravel, and boulders of glacial till or glacial outwash. Soils tend to be well-drained to excessively drained, and significant runoff is unlikely so that much of the precipitation will enter the soil and migrate to groundwater. Direction of groundwater flow is probably toward the nearest surface water, which is a wetland 600 feet to the northeast. This drains into, and is the source of, Cold Spring Brook. Less plausible directions of groundwater flow would be toward Mirror Lake, 1,000 feet to the south; toward the headwaters of Willow Creek, 1,000 feet to the north; or toward the Patton Well, 1,000 feet to the east-southeast.

3.3 SA 25 WASTE EXPLOSIVE ORDNANCE DEMOLITION (EOD) RANGE

The EOD range is located near the center of the South Post (Figure 3-3). Since 1979, about 1,200 pounds per year of explosives and ammunition have been disposed of at this range by either open burning or open detonation. The disposal pits are generally located in a 5-acre area along the southeastern boundary of the range. The site is included in the Fort Devens Resource Conservation and Recovery Act (RCRA) Part A permit application as a hazardous waste thermal treatment facility (Porter 1986).

The SA itself, at the east end of the EOD Range, is underlain by glacial-deltaic and outwash sands. Based on a previous investigation (Porter 1986), the soils are well-drained to excessively-drained sands with silty and clayey sands and some interbedded clay lenses. The SA is within a closed depression, the lip of which opens to the west, but no surface run-off is likely. The igneous and metamorphic rocks of this area, such as the Oakdale and Worcester formations or the Ayer Granite, are generally of much lower hydraulic conductivity than the overlying sands (see Section 2.1.3). Infiltration of precipitation is therefore expected to create a thin zone of saturation on top of the bedrock, which will flow along the bedrock surface. The most probable discharge point and nearest surface water are the headwaters of Slate Rock Creek, which originate in a wetland to the west of the EOD Range.



Source: Fort Devens, COE, NY, DWG, 18-02-24/4A, 1986

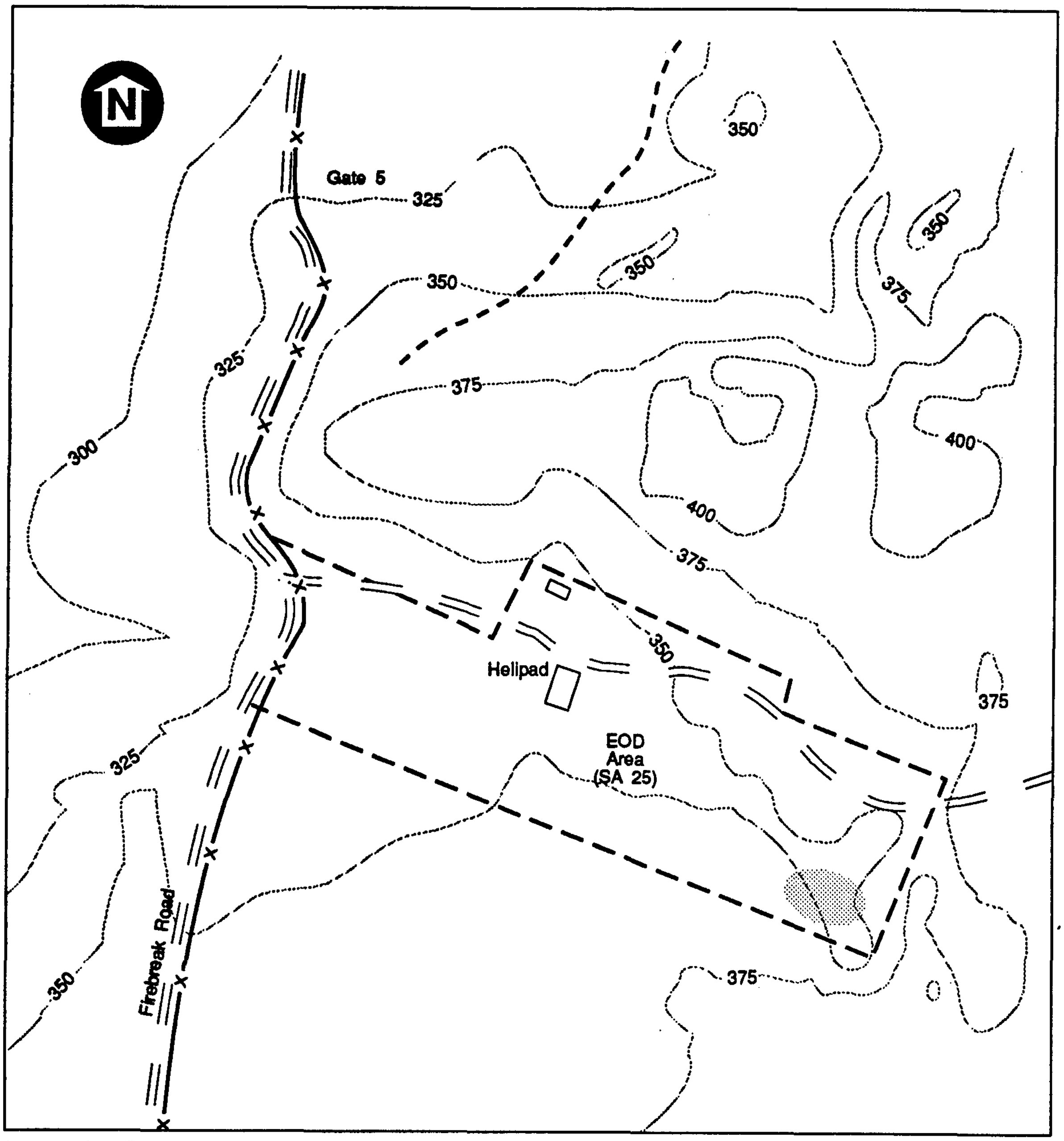
Legend

- ···275··· Contour (Hatched Indicates Depression)
- 3648 Building, Permanent
- T-3649 Building, Temporary
- Road, Surfaced
- Road, Unimproved
- —x— Fence

Scale In Feet
0 100 200 400

Figure 3-2 ILLUSTRATION OF STUDY AREA 24 (BUNKER 187)

00409L2.CDR



Source: Fort Devens, COE, NY, DWG 18-02-04 / 16-A, 1988

Scale in Feet
0 100 200 300 400 800

Legend

- 275 Contour
- Road, Unimproved
- Fence
- Building, Temporary
- EOD Area
- EOD Disposal Pit

Figure 3-3 ILLUSTRATION OF STUDY AREA 25 (EOD RANGE)

00409O3.CDR

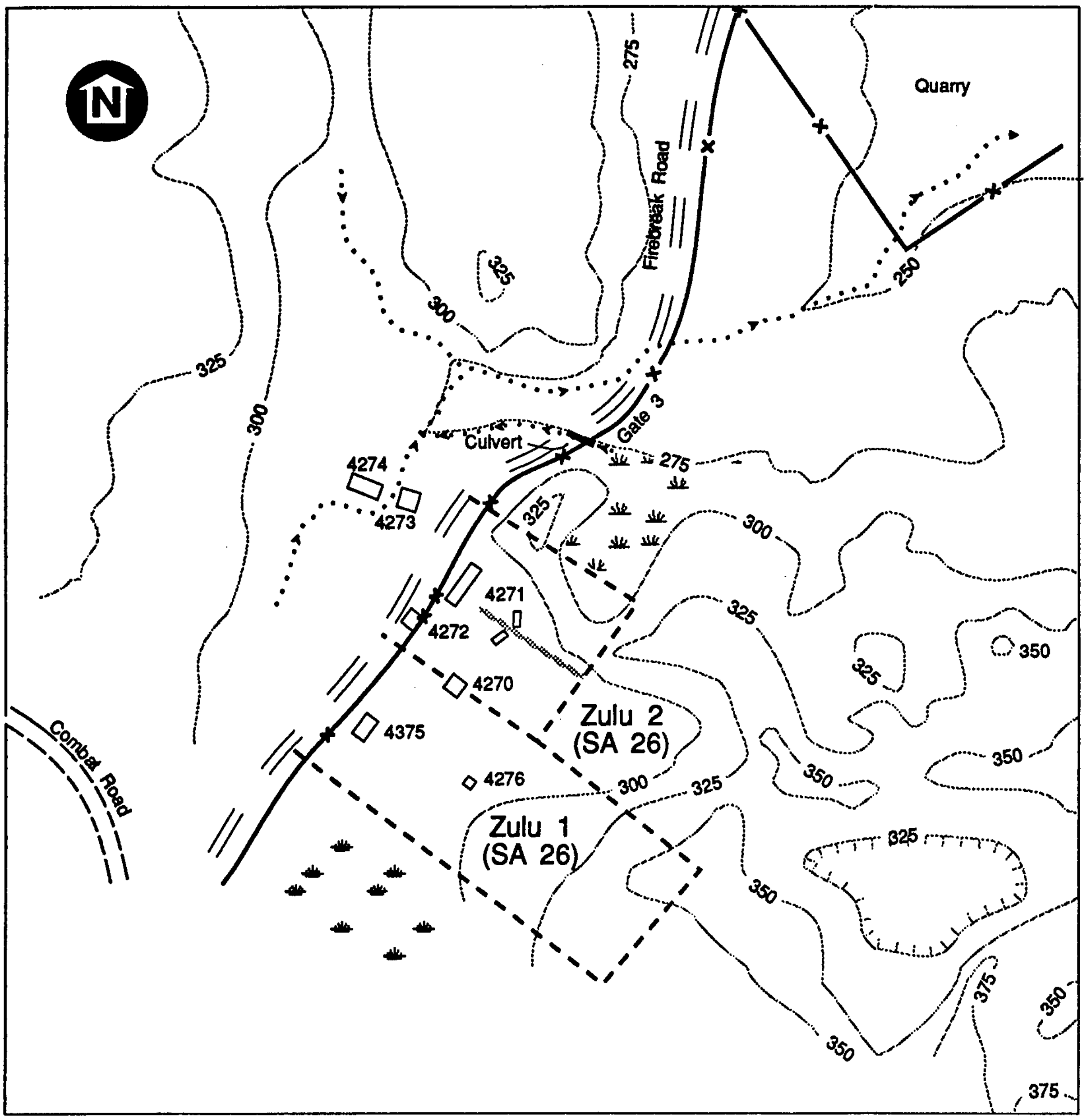
Open burning involves the placement of ordnance (small arms ammunition, smoke grenades, cartridge actuated devices and pyrotechnics) in a pit or trench within the designated 5-acre area. The items are completely covered with packing material, wood crates or cardboard; soaked with diesel fuel, oil and non-serviceable waste flammables; and ignited with smokeless powder charges. The pit is allowed to burn out and then cool for 24 hours. The items are then inspected for completeness of the burn. Typically, if the pit is to be reused, the items are excavated and buried nearby. If the pit is not to be reused, the pit is generally backfilled.

Open detonation is used on munitions and ordnance that contain explosive fillers. They are detonated with an explosive counter charge, such as Composition C-4 (Harrisite) or TNT in open pits or on a flat open surface. The procedure involves the placement of railroad ties side by side on a flat surface and the attachment of explosives to the uppermost exposed surface. This is designed to direct the force of the explosive counter charge downward, destroying the item through detonation.

In 1985, SA 25 was investigated by the USAEHA. Seven boreholes were drilled, six pits were excavated, and soil samples were collected. Analyses included EP toxic metals, explosives, volatile organics, and acid/base-neutral extractable organics. Analytical results from four of the seven borehole samples revealed the following elevated concentrations; trichloroethene (18,000 ppm), 1,1,1-trichloroethane (38 ppm), acetone (25 ppm), tributyl phosphate (up to 10 ppm),and bis(2-ethylhexyl) phthalate (up to 60 ppm) in the soil. Other constituents found at low concentrations were 2-butanone, di-N-octyl phthalate, 1,2-dichlorobenzene, di-N-butyl phthalate, trichlorofluoromethane, and trimethyl-2-heptene. Compounds that were found in very low levels in the pits were trinitrotoluene (TNT), bis(2-ethylhexyl) phthalate, di-N-butyl phthalate, diethyl phthalate, and N-nitrosodiphenylamine. The soil samples returned broad ranges for total metal concentrations; however, EP toxicity results revealed little if any potential for metals leaching.

3.4 SA 26 WASTE EXPLOSIVE DETONATION RANGE (ZULU 1 AND 2)

The 20-acre Zulu range is located in the South Post firing range and consists of two areas, Zulu 1 and 2 (Figure 3-4). Zulu 1 is a broad, gently inclined area used for burning and detonating explosives and items contaminated with explosives. Zulu 2 is a 10-acre area of uneven topography used primarily for hand grenade and demolition activity training. Past and current activities, as well as disposal methods, might have contributed to potential contamination of the soils with explosives and combustion residues. There is no evidence of removal of soils and material from the two ranges. However, the Zulu ranges are occasionally scraped and cleaned to improve appearance. There are no records to indicate that confirmation sampling was done to determine if explosive residues remained in the soil.



Source: Fort Devens, COE, NY, DWG, 18-02-26/16, 1988

Legend

- Contour
- Building, Temporary
- Road, Unimproved
- Wetland
- Fence
- Surface Drainage and Directional Flow
- Zulu Range
- Sand Barrier

Scale In Feet
0 100 200 300 400 800

Figure 3-4 ILLUSTRATION OF STUDY AREA 26 (ZULU 1 AND 2)

00409M2.CDR

Soils under the ranges are formed on what appear to be glacial-deltaic and outwash sands, and are well drained to excessively drained. This results in little run-off. Wetlands with poorly drained soils exist both north of Zulu 2 and south of Zulu 1. Both drain to Slate Rock Creek. Groundwater flow under the site is expected to be toward the wetlands or directly west to Slate Rock Creek.

3.5 SA 32 DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO YARD)

The DRMO yard is located in the Main Cantonment Area near the entrance to the Shepley's Hill Landfill (Figure 3-5). Records of operations are available as far back as 1964. A wide variety of items are stored at the DRMO, including scrap metal, vehicles, batteries, tires, and used office equipment. The northwest corner of the yard is dedicated to used lead-acid battery storage (all batteries having been drained prior to arrival). The west yard is completely paved with asphalt and had been used to store coal in the past. Soil samples, previously taken near the battery storage area, contained no elevated concentrations of EP toxic metals (Hopkins, 1988).

The site, as is most of the Main Cantonment Area, is situated on a glacial kame terrace deposit of stratified sands and gravels.

The soils at this site are thin, and bedrock of Ayers Granite (granodiorite) occurs within a few feet of the surface, as well as outcropping nearby in Shepley's Hill to the north and west, and to the east in a separate outcrop. At the surface, the soils are sandy and well drained.

It is probable that there is no permanent aquifer in the unconsolidated deposits above bedrock at this site, both because the soil is thin and well drained, and because it is near a watershed divide between the Willow Creek drainage to the west and Plow Shop Pond to the east. Any existing flow is probably toward Plow Shop Pond, which will cause it to flow under or into the Shepley's Hill Landfill. The bedrock surface configuration may determine local flow directions.

During E & E's preliminary site visit to Fort Devens in October 1990, personnel examining the DRMO yard recorded the observation of an excavation trench within the yard. The trench was reported to be part of the remediation of a rectifier oil spill, which was reported on April 5, 1990, to the Environmental Management Office (EMO) by DRMO personnel. The spill appears to be related to 3 units of a 1988 shipment of 11 rectifiers that were apparently sold as scrap. The three rectifiers in question were not claimed by the scrap dealer because they contained liquids, and the rectifiers were identified as possibly being contaminated with PCBs. These rectifiers were essentially abandoned within the DRMO yard and neglected for many months. Rain water entered the open rectifiers and displaced any oil or liquids in the housings.

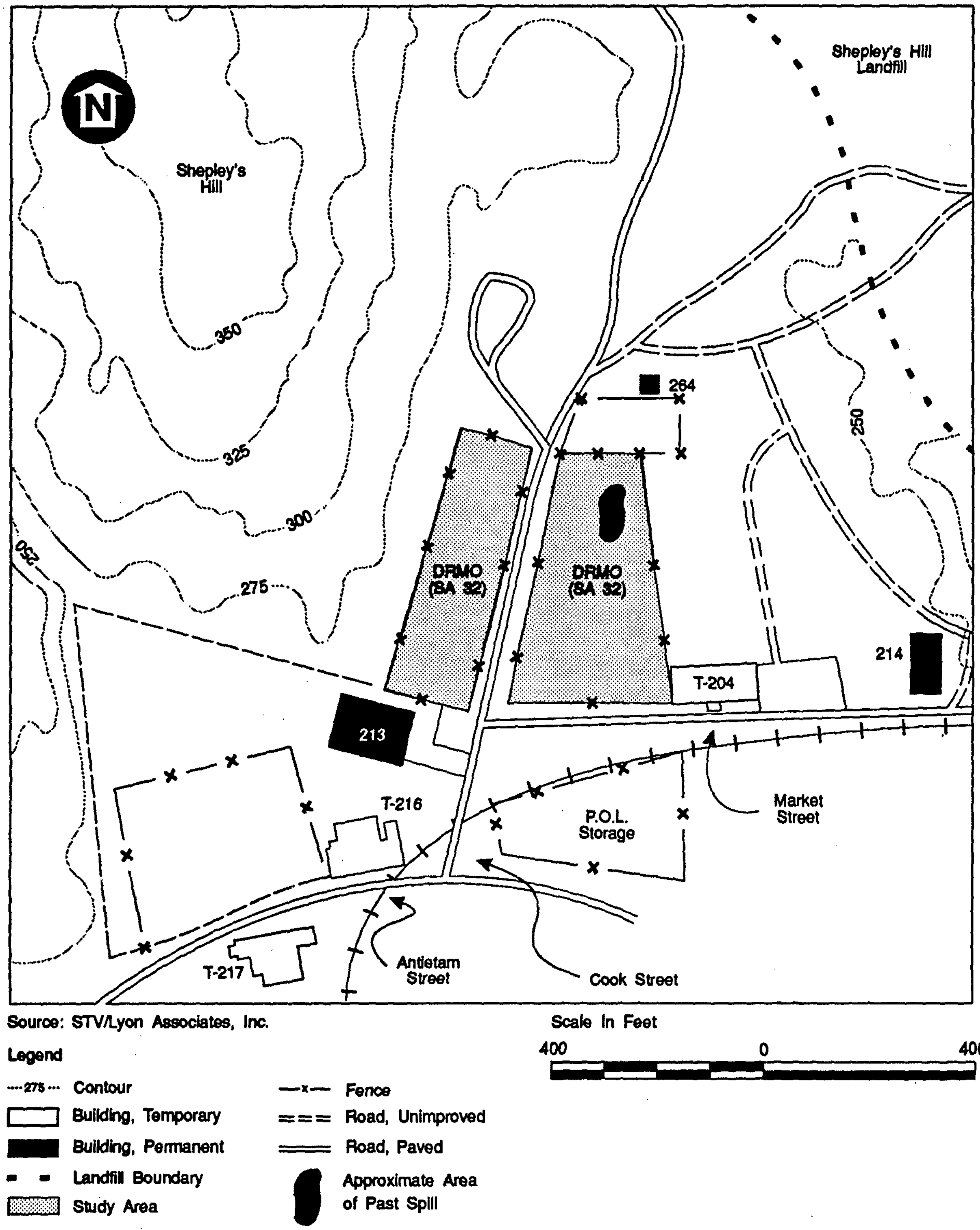


Figure 3-5 ILLUSTRATION OF STUDY AREA 32 (DRMO YARD)

Therefore, it is unknown how much liquid was originally in the housing, or at what concentrations, if any, of PCBs were contained in the fluids. Response actions eventually removed 600 gallons of fluids from the three remaining units and 40 cubic yards of asphalt and soil.

The response action was initiated after a Clor-n-oil field screening kit returned a positive response for PCBs. This test typically requires about 50 ppm of PCB to be present for a positive response. This same oil was later tested in the lab and was found not to contain PCBs although the analytical limit of detection was 21 ppm. The cleanup proceeded and the waste was handled as oil-contaminated waste. Further examination of the excavated soil identified degradation products of dichlorodiphenyltrichlorethane (DDT) above detection limits for certain pesticide compounds. Several metals were also found to be elevated following EP toxicity tests.

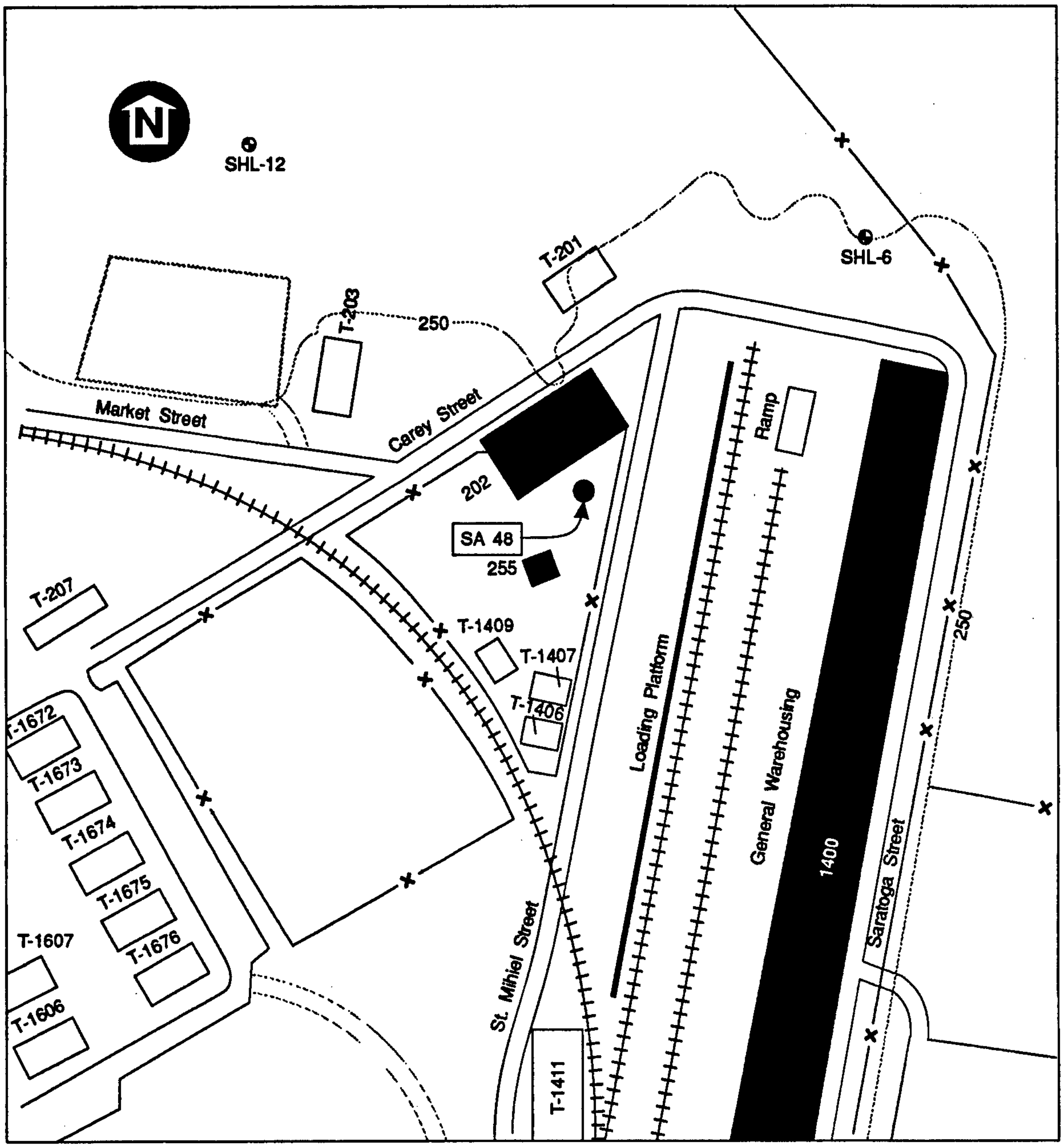
This earlier action has no direct bearing on the current investigation but it does point out a historic lack of environmental control on material within the DRMO yard. The current investigation will primarily determine if surface contamination exists inside the DRMO yard along the perimeter. Collection of samples from locations throughout the yard is not feasible due to the relatively impermeable asphalt surface.

3.6 SA 48 (BUILDING 202 UST)

Building 202 is located at the corner of Carey and St. Mihiel Streets in the northeast corner of the Main Cantonment Area directly south of the Shepley's Hill Landfill (Figure 3-6). In 1989, a 1,000-gallon UST was removed by Environmental Engineering and Geotechnics, Inc. (EE&G) along with approximately 100 cubic yards of petroleum-contaminated soil. Excavation stopped when total organic vapors in the excavation area dropped below 10 ppm. To quantify contamination in the excavation area, two soil samples were collected, the first of which yielded 916 ppm of total petroleum hydrocarbons (TPHC) and the second 3,212 ppm TPHC, well above the 100 ppm limiting criteria. Two soil borings were drilled and samples were collected and analyzed for TPHC.

The site is on the edge of a terrace of glacial/detaic or outwash sands about 1,500 feet south of Plow Shop Pond and 1,200 feet west of the southernmost point of Grove Pond. The Boston and Maine railroad embankment is located between the site and Grove Pond.

The soils are sandy and well-drained to excessively-drained. There is little or no evidence of surface run-off, and direct infiltration of the majority of precipitation to groundwater probably occurs, given the low slopes and permeable soils. Groundwater flow is probably north or northeast to Plow Shop Pond or possibly to Grove Pond, depending on the extent to which enhanced recharge on the flat and very permeable surface of the railroad embankment may have created a slight groundwater mound that could divert flow away from Grove Pond.



Source: Fort Devens, COE, NY, DWG, 18-02-48/4A, 1986

Legend

Building, Permanent

Building, Temporary

Road, Surfaced

Monitoring Well

Road, Unimproved

Fence

Railroad

Scale In Feet

400 200 0 400

Figure 3-6 ILLUSTRATION OF STUDY AREA 48 (BUILDING 202)

00409E1.CDR

The conclusion that the direction of groundwater flow is to the north and that hydrocarbons from the UST would flow in the same direction can be supported by examining the logs of the two boreholes drilled to 32 feet during the 1989 tank removal. In these boreholes, only the hole to the north (B-3) of the tank excavation identified any organic vapor at depth. The readings were also isolated to a specific depth (18 to 20 feet), and groundwater was encountered at 29 feet (EE&G 1989).

4. FIELD PROGRAM OBJECTIVES AND SAMPLING RATIONALE

The six study areas may be divided into two types. Those previously studied, and found to be contaminated, and those not previously studied. In the case of the first group, such as SA 25, SA 32, and SA 48, the primary objectives are to determine, if possible, what material is still left and to what extent it is migrating. Other factors to be determined are site conditions, such as slope, drainage, hydraulic gradient, hydraulic conductivity, and depth to groundwater, which can be used, in general terms, to predict at what rates and in what directions migration will take place.

A secondary objective is to identify the probable receptors, both human and environmental, and to estimate the seriousness of the probable effects migration of the contaminants could have on human health or the environment.

In the case of the second group, SA 15, SA 24, and SA 26, the existence and levels of contaminants are unknown, and the primary objective is to determine if contaminants are present, of what type and in what concentrations. To some degree, the extent of contamination, both horizontal, and at SA 15 and SA 24, vertical, will be determined.

Also at these sites, the site conditions that may be used to predict probable pathways and rates of migration will be noted, and the probable receptors, both human and environmental, will be recorded. E & E will also test locations in which immediately adjacent receptors are obvious, such as the wetlands flanking the Zulu ranges.

The ultimate result of these investigations is the development of a body of data that will allow USATHAMA and the regulatory agencies to classify each site into a category. Typically, the categories could be: adequately studied and found to be of no further concern; of sufficient concern to require immediate remedial measures; or insufficiently studied and requiring additional investigation. The last category might involve classifying sites with a wide range of requirements, from the need to obtain a few additional samples, to the requirement to proceed to a full-scale Remedial Investigation/Feasibility Study.

4.1 DATA REQUIREMENTS

Prior to deciding what kind and quality of data should be collected at any given site, a preliminary selection of standards and criteria that will be used to evaluate the data has to be made.

Within the complex Federal and State laws governing environmental and human health impacts of hazardous materials and hazardous substances, certain combinations of properties or concentrations of hazardous or toxic substances have been defined as being of particular concern.

These include, for example, hazardous wastes as defined by RCRA; Maximum Contaminant Levels (MCLs), as defined in the Regulations of the Safe Drinking Water Act; Water Quality Standards and Groundwater Quality Standards, as defined under the Code of Massachusetts Regulations; or Soil Cleanup Criteria for Polychlorinated Biphenyls, as defined by the regulations promulgated under the Toxic Substances Control Act (TSCA).

Any or all of these standards or criteria and others could be used to determine if a specific site poses unacceptable hazards to human health or the environment.

Many states, including the Commonwealth of Massachusetts, require that waters of the Commonwealth, which effectively include all fresh water aquifers and all surface water within the State, shall not be degraded. This leads to protection of existing uses, protection of high quality waters and National Resource Waters, control of eutrophication and protection of low-flow waters, as well as classification of surface water bodies and aquifers and designation of permissible uses. Minimum quality criteria have been established for both surface water and groundwater within the Commonwealth.

Specific data objectives include the collection of data of sufficient quality to determine adequately if the SAs actually contain hazardous wastes; require clean-up or removal of wastes or soil; cause exceedances of MCLs; or violate State standards. In general, the data should be of sufficient quantity and quality to permit a determination of whether the SA violates such standards or poses an unacceptable risk to human health or the environment.

The data requirements vary from site to site, depending on the availability of data from previous investigations, the site setting, the probable contaminants, and the probable routes of migration.

For example, where there is no indication that past practices at a site such as Bunker 187 have resulted in the release of any materials, the primary concern is to determine if the most immediately adjacent media are contaminated, such as the surface soils outside the building. If not, there is a fair presumption, absent other evidence, that if contaminants exist, they have not migrated outside the bunker. Since this site handled only explosives, explosives are the only analyses required for all samples.

At the EOD Range, where intrusive soil sampling had previously shown the occurrence of contaminants, including those such as chlorinated solvents with an ability to migrate rapidly, the data requirements were those needed to evaluate the actual and potential migration rates. For these reasons, the investigation requires the installation of monitoring wells into the first aquifer under the site, the geological logging of the boreholes, the measurement of aquifer hydraulic conductivity where possible, the determination of hydraulic gradients, and the measurement of groundwater quality.

At each site, the data requirements have been tailored to site conditions, but in all cases, one or more samples of the media examined have been analyzed for a wide range of organic and inorganic contaminants to ensure that significant contamination caused by past practices not recorded in the files or recollected by present site personnel would not go undetected.

4.1.1 Data Quality Objectives (DQOs)

To attain the specific data objectives, the data must be of adequate quality. Primary control of data quality is maintained in two ways: by use of a USATHAMA certified laboratory and by adherence to USATHAMA geotechnical guidelines in the collection of geotechnical data. Secondary controls are provided by sample collection and chain of custody protocols, as well as by management guidelines. These types of controls are discussed in the QAPjP.

Given data of adequate quality, DQOs are achieved by ensuring in advance of analysis that the analytical and field protocols proposed will provide detection levels that allow determination of whether any given sample violates the applicable standard or criterion.

For example, a Toxicity Characteristic Leaching Procedure (TCLP) test properly conducted will, by definition, decide whether a waste is hazardous under RCRA, and banned from land disposal without further treatment. Similarly, unless there are matrix interference problems, a groundwater sample will have detection limits below the MCLs and it will be immediately apparent from the analysis if the groundwater exceeds an MCL. Peer review and adherence to EPA guidelines for report quality are used to ensure that the data quality is maintained through the report stage.

4.1.2 Site-Specific Scopes of Work

The following six SA sites were selected for a structured investigation to determine the presence or absence of contamination at the sites. E & E selected each appropriate sampling rationale on the basis of past activities at these sites. The field program will potentially include geophysical surveys, soil-gas analysis, surface/subsurface soil sampling, well installation, aquifer tests, groundwater sampling, groundwater elevation measurements, and surface water/sediment sampling at the appropriate SI sites.

Included in the following sections is a description of the types and number of samples to be collected. Please refer to the Field Sampling Plan for additional samples required for QA/QC (field blanks, trip blanks, and rinsate blanks).

4.2 SA 15 (LANDFILL NO. 11)

Gates (1987) identified this landfill on a general site location map and with a set of Universe Transverse Mercator (UTM) map coordinates. On subsequent base maps of the AOCs/SAs, SA 15 is located west of Jackson Road and east of the helipad on the South Post. The primary concerns are that the actual location of the landfill might be incorrect and that there might be other potential sources of contamination in the immediate area. Therefore, E & E attempted to locate and analyze aerial photographs of the general area for the period in question, the late 1960s. Preliminary examinations of photos from 1967 have identified two trenches along Jackson Road, but much farther south than the identified location for SA 15 (see Figure 3-1). The area believed to be SA 15 does show surface soil disturbance, but no trenches. The goal is to identify the approximate boundary of the landfill(s) in which the oil was burned.

A geophysical survey, using an EM-31 and a proton precession magnetometer, will be conducted to measure the magnetic variability and the electrical conductivity of the SA in order to map anomalous readings that might be attributable to the waste oil pits. If this study should prove inconclusive, a qualitative soil-gas study will be initiated. Areas targeted by each method will be examined with a shovel or hand auger prior to sampling. At least one borehole will be placed inside each target area, the number of boreholes depending on the number of targets identified, either by photo or by geophysical anomaly.

Once the target areas have been identified, the focus will shift to determining if contamination exists and has migrated downward into underlying soil. This will be achieved by drilling a maximum of 4 25-foot-deep boreholes inside the target areas and collecting 40 subsurface soil samples, 10 from each borehole at 2.5-foot intervals. The 40 samples will be analyzed for TCL organics, TAL metals, and TPHC. Three of the 40 soil samples will be further examined using the TCLP for metals and organic compounds, to determine if leachable components could be migrating from the site. See Figure 4-1 for proposed sampling locations.

In accordance with USATHAMA geotechnical requirements, geotechnical samples will be collected at each borehole at 5-foot intervals. Between 10 and 20 percent of these samples will be subjected to sieve grain size analysis, and Atterberg Limits testing, and assigned a soil classification systems symbol.

After conducting the site visit and reviewing existing reports and aerial photographs, E & E has determined that there are no substantial modifications required for this investigation. Note that the actual placement of the soil borings will depend on the results of the geophysical and soil-gas surveys. The selection of appropriate locations will be made in the field after all pertinent data have been reviewed with the Fort Devens Installation engineers, EPA, MDEP, and the Contracting Officer/Contracting Officer's Technical Representative. The exact methodologies of the geophysical and soil-gas surveys will be tailored to the specific conditions at the site and the goals of the statement of work (SOW) to "determine the extent of the landfill."

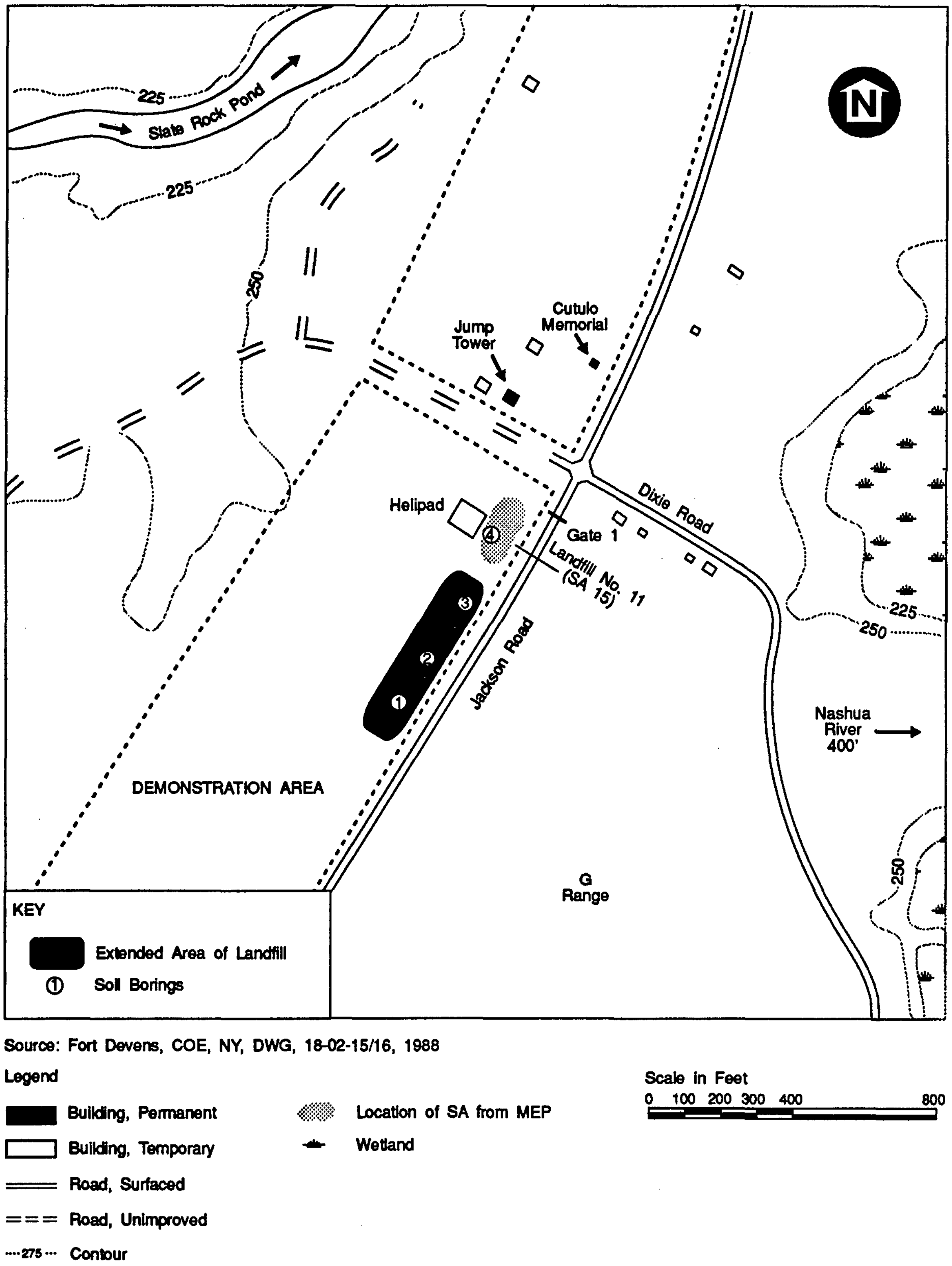


Figure 4-1 BOREHOLE SAMPLING LOCATIONS AT STUDY AREA 15 (LANDFILL NUMBER 11)

0040916.CDR

The data collected will provide spatial definitions for the contaminant source(s) and will identify concentrations of compounds and potential migration pathways. It will then be possible to determine what further steps, if any, need to be taken to investigate or remediate this site.

4.3 SA 24 (BUNKER 187)

The concern at this site is to determine whether the explosives stored at this bunker were handled properly, and to ensure that no spills occurred in the general area of the bunker. To this end, E & E proposes to collect and analyze five surface soil samples for explosives. One of the five soil samples will be further examined using TCLP and analyzing the extract for metals and organics. See Figure 4-2 for sample locations.

Following the site visit to the bunker, which included an examination of the inside of the bunker, there are no substantial modifications required for this investigation. It is noted that no samples are to be taken inside the ammunitions bunker at this time.

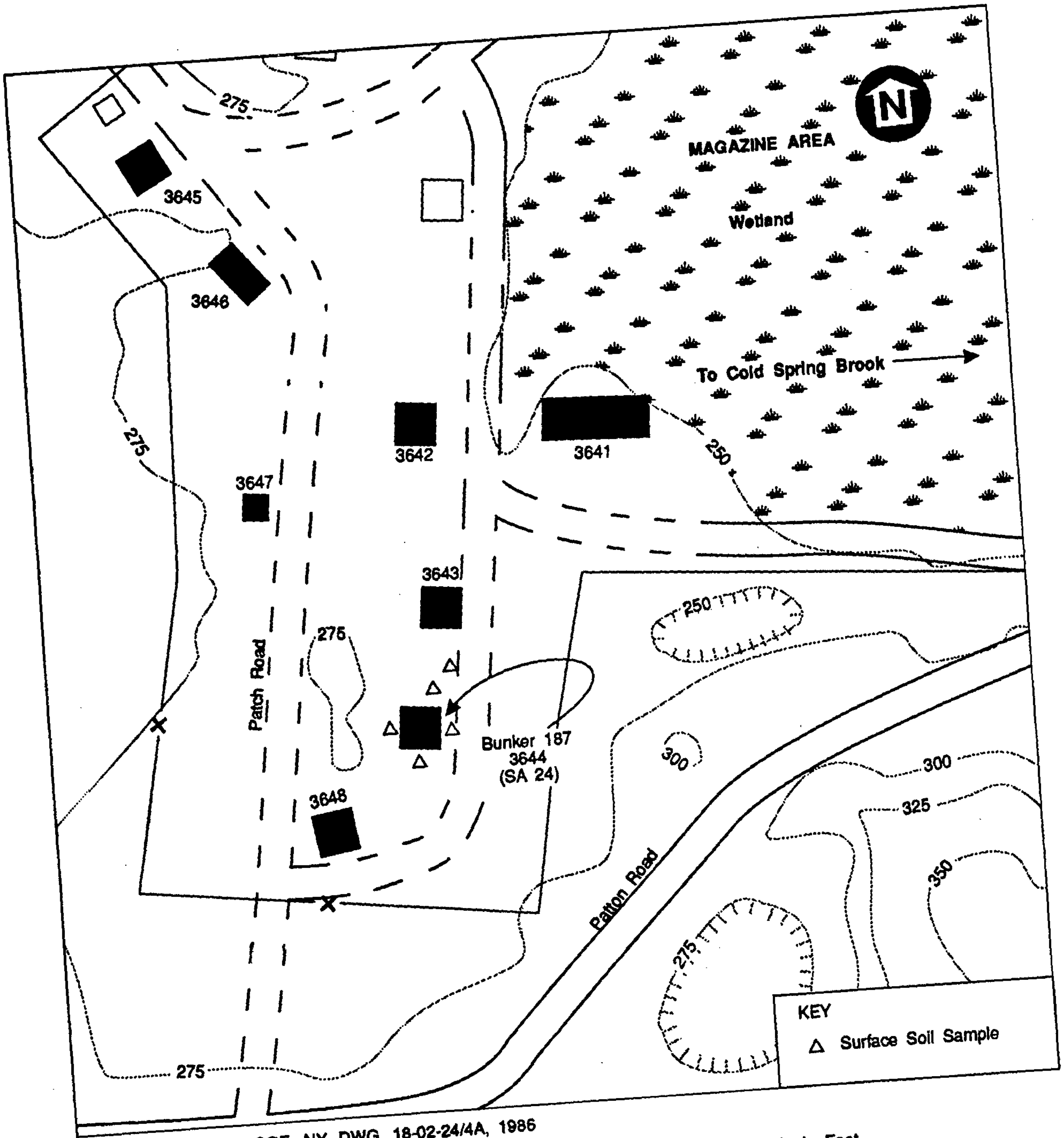
The data will indicate whether spills or unreported releases of explosive products occurred at the site and whether the soils contain leachable contaminants of concern. From this information, a determination can be made on whether the site warrants a recommendation for further investigation.

4.4 SA 25 (EOD RANGE)

The EOD Range is an active range and will continue to be utilized for training and ordnance disposal. Because of this, all field members conducting work on this range will be accompanied by a fully qualified unexploded ordnance (UXO) detection team, who will provide clearance to any sampling, boring, or well installation sites, both while conducting field work and during subsequent visits for water level measurements or repeat sampling.

In 1985, SA 25 was investigated by the USAEHA. Seven boreholes were drilled, six pits were excavated, and soil samples were collected. Analyses identified residual amounts of toxic metals, explosives, volatile organics, and acid/base-neutral extractable organics (Porter, 1986). As a result, additional soil sampling is not required.

The present concern at this site is to determine if residue from the previous burnings or detonations present a threat to the local groundwater aquifer. Because soil characterization has been performed, the purpose of this study is to close existing data gaps. This is the rationale for drilling and installing four groundwater monitoring wells.



Source: Fort Devens, COE, NY, DWG, 18-02-24/4A, 1986

Scale In Feet: 0, 100, 200, 400

Legend

- ····275···· Contour (Hatched Indicates Depression)
- 3648 Building, Permanent
- T-3649 Building, Temporary
- Road, Surfaced
- Road, Unimproved
- —x— Fence

Figure 4-2 SITE INVESTIGATION SAMPLING POINTS AT STUDY AREA 24 (BUNKER 187)

00409L1.CDR

In accordance with USATHAMA geotechnical requirements, geotechnical samples will be collected at each borehole at 5-foot intervals. Between 10 and 20 percent of these samples will be analyzed for sieve grain size analysis, Atterberg Limits, and soil classification system symbol.

E & E will measure groundwater elevations in the wells on three separate occasions throughout the investigation. Water elevation will be collected on completion of the new monitoring wells, and quarterly measurements will be performed thereafter. Water samples will be collected at two different times, over 3 months apart, and will be analyzed for TCL, TAL, TPHC, explosives, hardness, and the following ions: calcium, magnesium, potassium, bicarbonate chloride, sulfate, nitrate, and total Kjeldhal nitrogen, and dissolved oxygen. Quantification of aquifer characteristics will be conducted by performing aquifer slug tests in each new well. See Figure 4-3 for sampling locations.

If significant contamination is found, additional study will be recommended. If no problems are found, the wells should be maintained for continued groundwater monitoring.

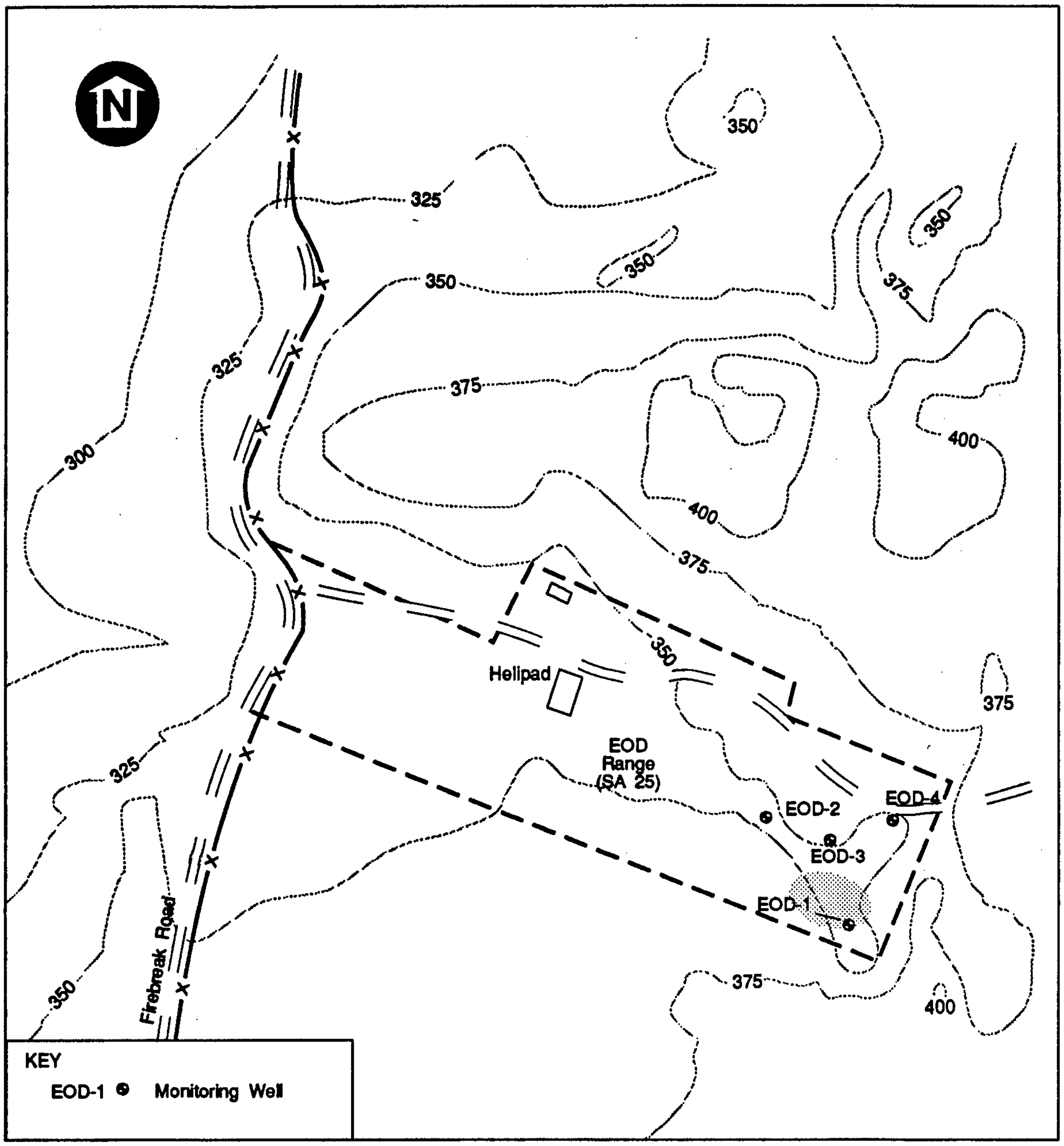
4.5 SA 26 (ZULU RANGE)

The Zulu Range is also an active range that consists of areas Zulu 1 and Zulu 2. Again, no sampling or other activities will take place on the range without access and work sites being cleared by a UXO detection team. The general concern is whether detonation residue from ordnance is accumulating in soils and migrating toward adjacent surface water either in runoff or in groundwater. The surface waters in question are the wetlands located south of Zulu 1 and north of Zulu 2.

At this site, multi-media sampling will include surface soil, subsurface soil, surface water, and surface sediment samples, as shown in Figures 4-4A and 4-4B. The surface and subsurface soils will be collected from 22 pits, excavated to a maximum depth of 10 feet each in the active areas of the range. Three soil samples will be collected from each boring for a total of 66 samples. These 66 soil samples will be analyzed for TCL organics and metals and explosives. Four soil samples, two from 4 to 5 feet, and two from 9 to 10 feet (see Appendix B), will be further analyzed for leachable metals and organics using TCLP.

In accordance with USATHAMA geotechnical requirements, geotechnical samples will be collected at each borehole at 5-foot intervals. Between 10 and 20 percent of these samples will be analyzed for sieve grain size analysis, tested for Atterberg Limits, and assigned a soil classification systems symbol.

A total of 10 sets of surface water and surface sediment samples will be collected; 8 sets from the wetlands south of Zulu 1 and 2 sets from the north of Zulu 2, for a total of 20 samples. Surface water



Source: Fort Devens, COE, NY, DWG 18-02-04 / 16-A, 1988

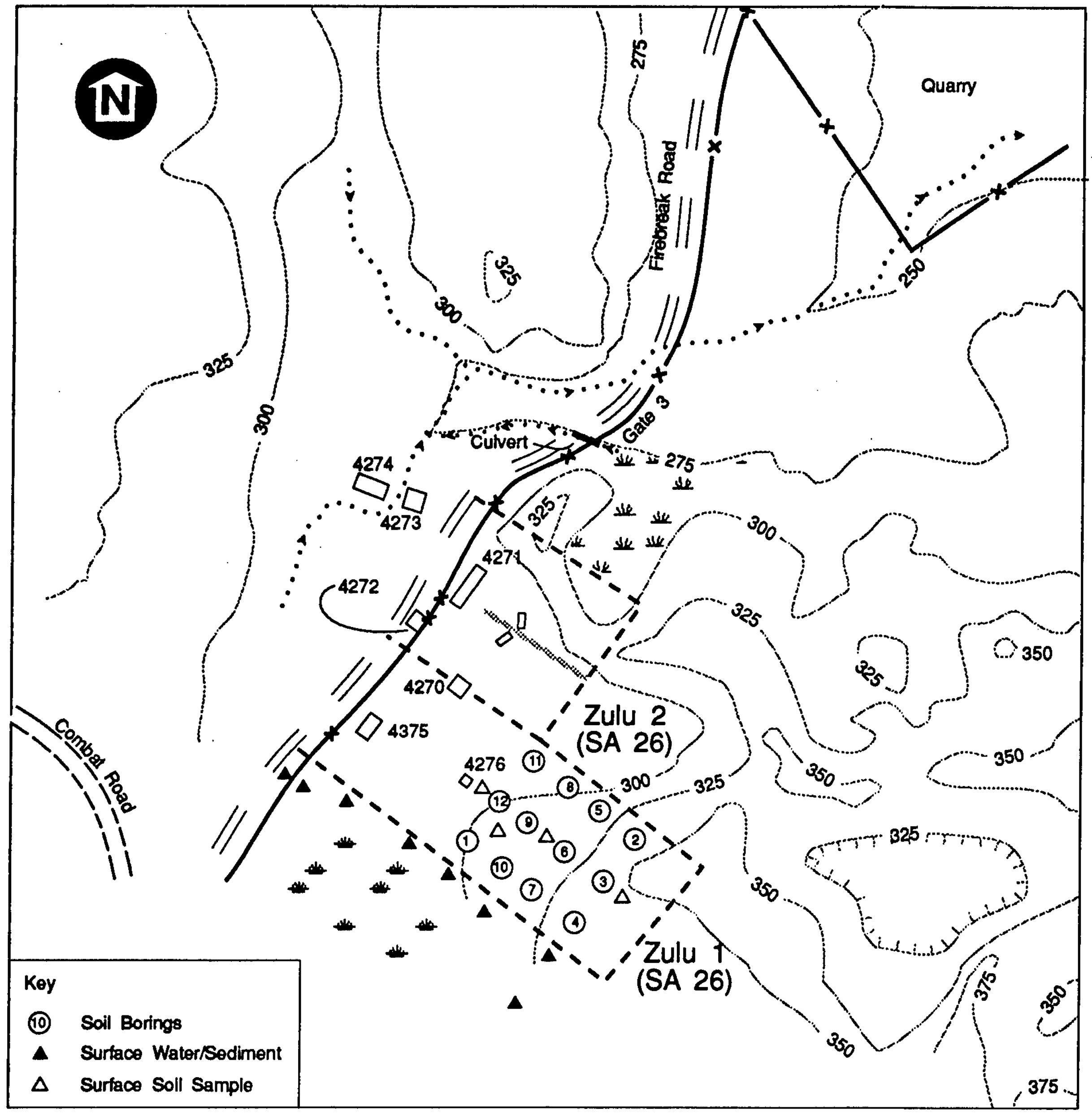
Scale in Feet
0 100 200 300 400 800

Legend

—275— Contour
=== Road, Unimproved
—x— Fence
Building, Temporary
- - - EOD Range
EOD Disposal Pit

Figure 4-3 MONITORING WELL LOCATIONS AT STUDY AREA 25 (EOD RANGE)

00409O2.CDR



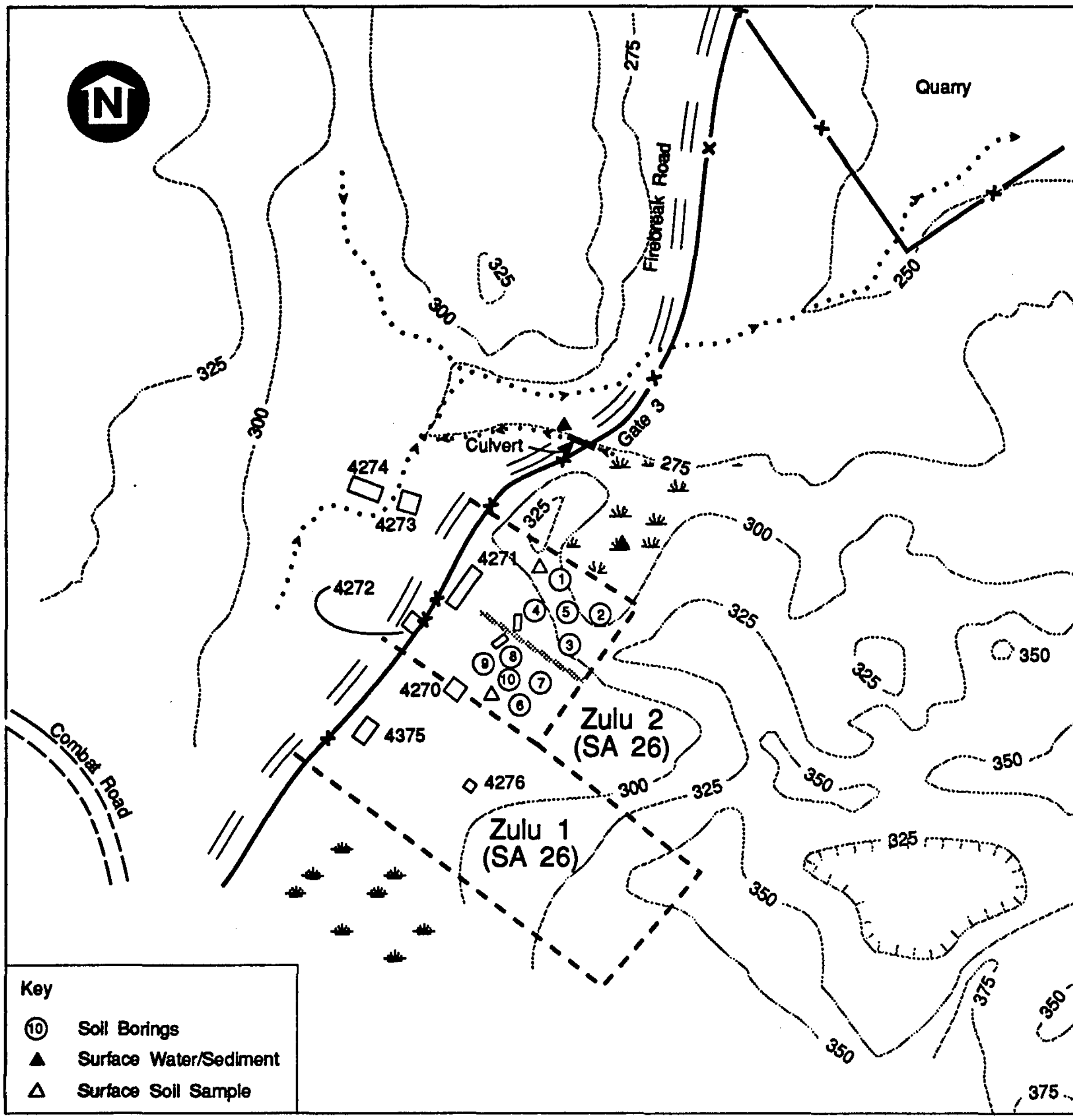
Source: Fort Devens, COE, NY, DWG, 18-02-26/16, 1988

Legend

Scale In Feet
0 100 200 300 400 800

- 275 Contour
- Building, Temporary
- Road, Unimproved
- Wetland
- Fence
- Surface Drainage and Directional Flow
- Zulu Range
- Sand Barrier

Figure 4-4A SITE INVESTIGATION SAMPLING POINTS AT STUDY AREA 26 (ZULU 1)



Source: Fort Devens, COE, NY, DWG, 18-02-26/16, 1988

Legend

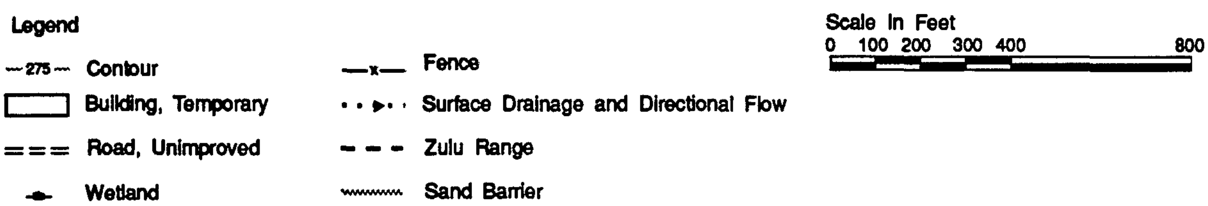


Figure 4-4B SITE INVESTIGATION SAMPLING POINTS AT STUDY AREA 26 (ZULU 2)

00409M1.CDR

samples will be analyzed for TCL organics and metals, explosives, TPHC, dissolved oxygen, and hardness. Sediment samples will be analyzed for TCL, TAL, explosives, TPHC, and TOC. Since there is no previous data from Zulu on explosive residues in the soils, 6 preliminary soil samples will be qualitatively analyzed for explosives as a safety precaution prior to extensive field work.

4.6 SA 32 (DRMO YARD)

The DRMO yard is a large open compound where excess and damaged equipment is stored prior to disposal or sale. There are many potential sources of hazardous substances associated with this operation (e.g., scrap metal, crankcase oil, and photographic solutions). In order to determine if hazardous substances are present and have been released, it is suggested that 11 surface soil samples be collected and analyzed for TCL, TAL metals, and TPHC, at locations around the perimeter as shown on Figure 4-5. Two of the samples will be further examined by the TCLP for leachable metals and organics.

The SI will determine the probable soil contamination within and around the DRMO yard.

4.7 SA 48 (BUILDING 202 UST)

As described in Section 3.6, a leaking tank was removed and replaced with clean fill at SA 48. However, residual contamination was later documented (EG&G, 1989). The sampling rationale for the present investigation is based on the need to establish the presence and extent of remaining hydrocarbons within the soil, floating on the groundwater, or dissolved in the groundwater.

In order to determine the hydrologic condition below the SA, the plan is to drill and install three groundwater monitoring wells to the water table. These well locations are shown on Figure 4-6. The groundwater elevations will be measured at three different times over the period of 1 year and all wells will be slug tested to estimate the hydraulic conductivity of the aquifer. This will enable the potential for off-site migration and the rate of potential migration to be determined. The analytical phase requires that two rounds of groundwater samples be collected from each of the three new wells, at least 3 months apart, and analyzed for TCL, TAL, TPHC, and for some common ions (calcium, magnesium, potassium, bicarbonate, chloride, sulfate, nitrate, total Kjeldhal nitrogen, and dissolved oxygen).

Since subsurface soil contamination was documented, it would be important to collect subsurface soils samples as close to the suspected contaminant source as possible. The locations of the monitoring wells are approximately 325 feet (B202-1), 150 feet (B202-2), and 175 feet (B202-3) away from the former tank location. These wells are too far from the known area of residual soil contamination to be appropriate soil sampling locations for determining the depth and degree of residual contamination. Therefore, the plan is to drill one 35-foot-deep boring

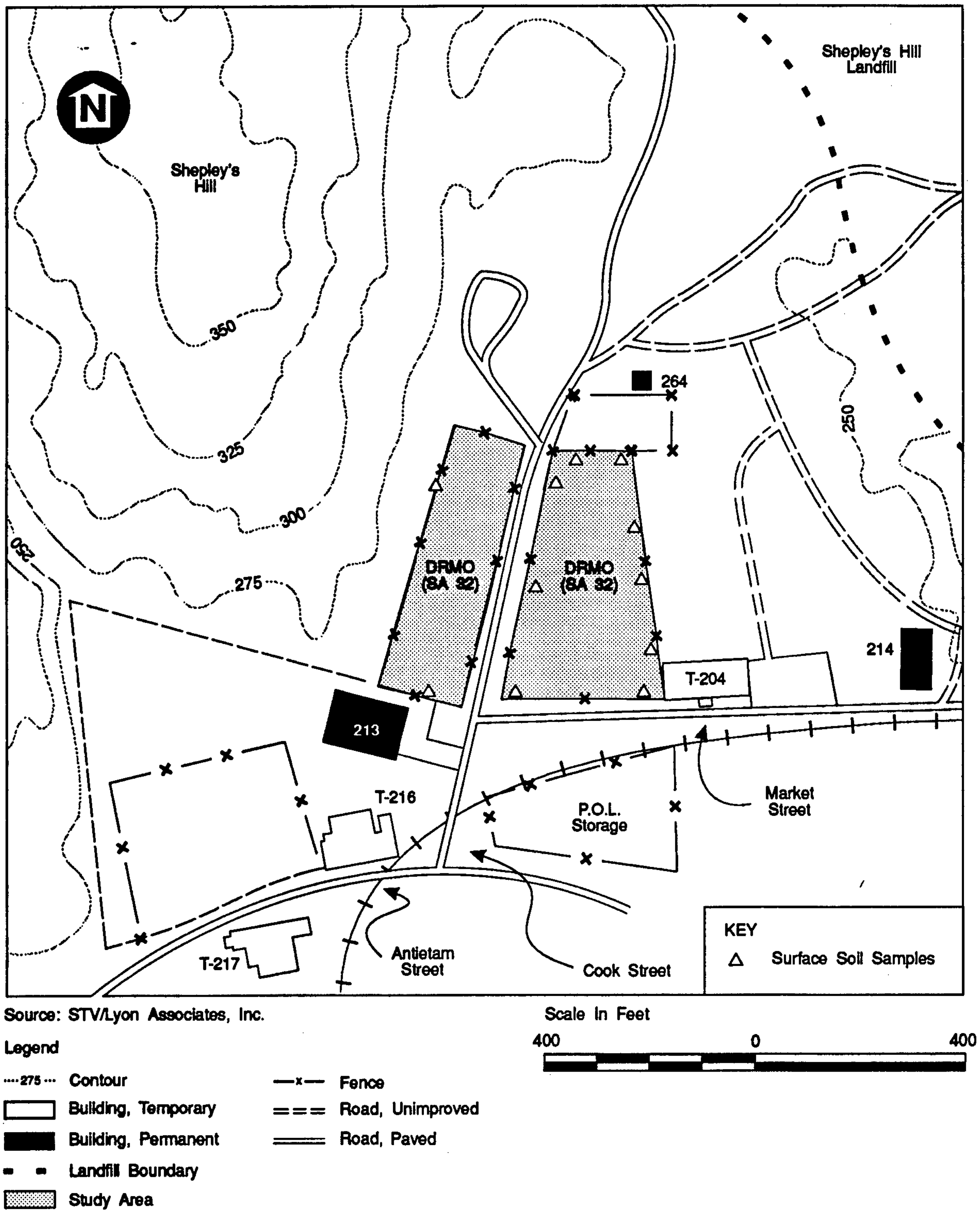


Figure 4-5 SAMPLING LOCATIONS AT STUDY AREA 32 (DRMO)

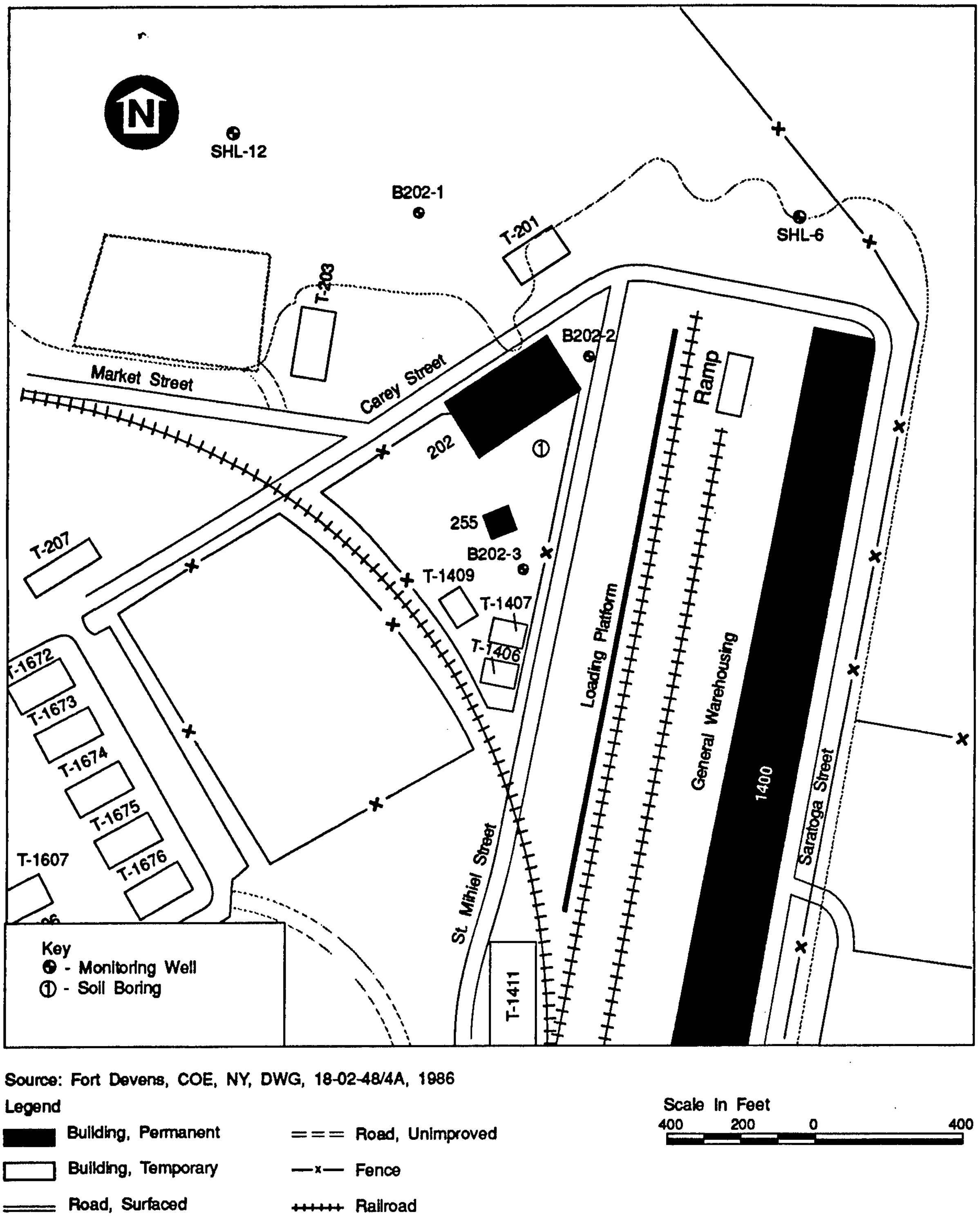


Figure 4-6 SITE INVESTIGATION SAMPLING POINTS AT STUDY AREA 48 (BUILDING 202)

directly adjacent to the contaminated area and to collect seven subsurface soil samples at approximately 5-foot intervals (Figure 4-6). These seven subsurface soil samples would be analyzed for TPHC.

In accordance with USATHAMA geotechnical requirements, geotechnical samples will be collected at each borehole at 5-foot intervals. Between 10 and 20 percent of these samples will be subjected to a sieve grain size analysis, an Atterberg Limits test, and assigned a soil classification systems' symbol.

The result of the study will provide critical aquifer information while testing for aquifer contamination. The soil boring will present information on subsurface conditions to a depth of 35 feet and determine whether the problem is limited to the top of the water table or extends much deeper.

5. PROJECT PLAN FOR SITE INVESTIGATION

In accordance with EPA guidelines and the interagency (Federal Facility) agreement for Fort Devens, this SI Work Plan describes the necessary tasks to implement the SI scope of work. This section of the Work Plan describes the overall plan for completing the SI project. The SI Plan, which is specific to six Fort Devens SI SAs, addresses the following areas:

- project planning,
- data review,
- data quality objectives,
- field investigations,
- interim field investigation report,
- analytical program,
- data management,
- data evaluation,
- applicable or relevant and appropriate requirements (ARAR) identification, and
- site investigation report.

The purpose of the SI project plan is to specify a step-by-step approach for implementing SI activities from conception of the initial Work Plan through preparation of the final SI Report.

The SI Project Plan describes the plan preparation tasks, SI site characterization tasks, data evaluation approach, and preparation of associated reports. Procedural details are contained in the Quality Assurance Project Plan (QAPjP) and SI Field Sampling Plan (FSP). The following subsections describe the 10 SI tasks.

5.1 PROJECT PLANNING

Project planning continues throughout the project and includes all efforts to initiate and complete the project. The following elements are included in this task: project organization, scheduling, project management, meetings/site visits, and preparation of project plans. Each element is described in the following subsections.

5.1.1 Project Organization

Project organization entails designating project positions, assigning appropriate personnel, establishing communication channels, and developing the project schedule. The Project Organization Chart and Project Schedule are presented in Section 6. The USATHAMA Contracting Specialists are Timothy Frazier and Kathleen Lavinka, respectively, and the Contracting Officer's Technical Representative (COTR) is Mary Ellen Heppner.

5.1.2 Meetings/Site Visits

Meetings between involved parties (i.e., USATHAMA, Fort Devens DEH, E & E, U.S. Fish and Wildlife Service, EPA, and MDEP) are imperative to ensure project operations to proceed as scheduled. Under this task order, 12 major meetings/site visits are anticipated.

Quarterly briefings with the Technical Review Committee (TRC) are scheduled throughout the project to report progress and discuss any concerns. E & E may be called upon to support USATHAMA at the regulatory briefing and in the final regulatory briefing that will include a public presentation of SI results.

5.1.3 Preparation of Project Plans

E & E has prepared project plans (i.e., support and work plans) necessary to conduct the six SIs.

Support plans include the QAPjP, which describes general field analytical procedures and QA/QC measures; the Health and Safety Plan (HASP), which identifies potential hazards at Fort Devens, recommends personal protection equipment for personnel performing field investigation activities, and provides site-specific safety plans; the Community Relations Plan (CRP), which describes the avenues for public review and comment on the SI work; and the SI Field Sampling Plan, which describes the detailed methods to be used for conducting field work and collecting and handling samples.

The objective of the SI Work Plan is to present clear and concise descriptions of the SA, conceptual models of the SA environs, and a technical approach to determine if a significant release has occurred.

The SI Work Plan also specifies preliminary location-specific and chemical-specific standards and criteria for Fort Devens, based on known site conditions before implementation of field activities. Identification of preliminary standards and criteria is part of the project planning task.

5.2 DATA REVIEW

Since the early 1980s, areas of Fort Devens have been studied for environmental contamination resulting in a varying amount of environmental data for the locations studied. Review of these data is essential to develop a thorough understanding of potential chemical releases at the six SI SAs, to help in determining data gaps, and to provide a more focused investigation. E & E conducted a significant data review effort before preparing the project plans. However, E & E found that only limited data were available at the six SAs, much of which was incorporated into the general site history and natural setting, and into the initial evaluation of SAs (Sections 2.2 and 2.3 of this report).

5.3 DATA QUALITY OBJECTIVES

Establishing Data Quality Objectives (DQOs) is necessary to establish the level of detail required for the assessment task. Data generated during the SI will be used to develop the site characterization and preliminary risk assessment. Subsequently, the data will be used to scope future investigations or to support a decision for no further action. Data generated in the SIs will have different levels of quality. Level I corresponds with the lowest quality, but most rapidly attainable data; Level IV is the highest quality data, requiring extensive quality control and review before its release. Level V pertains to laboratory analysis for non-standard parameters. Table 5-1 specifies the USATHAMA Certification Classes and DQOs for the SI Analytical Laboratory Program. Table 5-2 presents DQOs for SI field measurements.

5.4 FIELD INVESTIGATIONS

This subsection provides an overview of SI field investigations to be implemented at Fort Devens. A more detailed description of SI field procedures and QA protocols is presented in the SI FSP and the QAPjP, respectively.

5.4.1 Subcontractor Procurement

To support the implementation the SI Work Plan at Fort Devens, subcontractors will be procured to perform the following activities:

(1) Monitoring Well Installation - Under the direction of E & E geologists during Delivery Order 001, E & E will use its own company, E & E Drilling & Testing, to install 4 monitoring wells and 4 borings on SI sites.

(2) UXO Clearing - A UXO subcontractor, UXB International, Inc. (UXB), will clear three SIs involving potential UXO hazards prior to any field work, including intrusive and non-intrusive work.

UXB meets USATHAMA requirements that include the following:

- the firm has fully certified operatives to perform EOD operations,
- the firm has recent experience with projects similar to the Contract project,
- the firm has graduates of the U.S. Naval School of Explosives Ordnance Disposal,

Table 5-1

USATHAMA CERTIFICATION CLASSES AND DQOs FOR THE SI ANALYTICAL LABORATORY PROGRAM

Medium	Parameter	Method	Classes[1]	Level[2]
Soils/Sediments	TCL-VOCs	Purge & Trap GC/MS	1A	IV
	TCL-SVOCs	GC/MS	1A	IV
	TAL-Metals	AAS/ICP	C1	IV
	Mercury	Cold Vapor AAS	C1	IV
	TCL-Pesticides/PCBs	GC/ECD	1B	IV
	Explosives	HPLC	C1	V
	TCLP	Extraction	C1	IV
	Petroleum HCs	Infrared Spectroscopy	--	III
	TOC	Infrared Spectroscopy	--	III
Groundwater/ Surface Water	TCL-VOCs	Purge & Trap GC/MS	1A	IV
	TCL-SVOCs	GC/MS	1A	IV
	TAL-Metals	AAS/ICP	C1	IV
	Mercury	Cold Vapor AAS	C1	IV
	Anions	Ion Chromatography[3]	C1	III
	TCL-Pesticides/PCBs	GC/ECD	1B	III
	Explosives	HPLC	C1	V
	Petroleum HCs	Infrared Spectroscopy	--	III

NOTES:

--Not certified under USATHAMA Program
1 USATHAMA, 1990. Certification Classes:
  1A - GC/MS laboratory methods
  1B - Low sample through-put methods (non-GC/MS)
  C1 - Non-GC/MS, non-low through-put laboratory methods
2 USEPA, 1987b. DQO Levels.
  Level III Laboratory analyses using USEPA or equivalent procedures for standard parameters.
  Level IV USATHAMA methods modified to meet EPA requirements for Level IV DQOs
  Level V Laboratory analyses using USEPA or equivalent procedures for non-standard parameters.
3 Analytical methods for anions and water quality parameters vary based on certification of individual laboratories. Refer to Table 8-1 of the QAPjP.

Abbreviations:

AAS - Atomic Absorption Spectroscopy
GC/ECD - Gas Chromatography/Electron Capture Detection
GC/MS - Gas Chromatography/Mass Spectrometry
HCs - Hydrocarbons
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Spectroscopy
PCBs - Polychlorinated Biphenyls
TCL - Target Compound List
TCLP - Toxicity Characteristic Leaching Procedure
TOC - Total Organic Carbon
VOCs - Volatile Organic Compounds
SVOCs - Semivolatile Organic Compounds

Table 5-2

DQOs FOR THE
SI FIELD MEASUREMENTS

Media	Method Type	Method	Parameter of Interest	DQO Level
Soils	Field screening	pH meter	pH	I
	Field screening	PID/FID	VOCs	I
	Lab screening		Explosives	V
Source areas	Survey	Magnetometry	Buried wastes and covered trenches/burn pits	N/A
Source areas	Survey	Ferex Ordnance	UXO clearance	V
Groundwater/ Surface Water	Field screening	Y.S.I. Meter	Temperature/ Specific Conductance Dissolved Oxygen	I
		pH meter	pH	I
Survey	Survey	--	Location/ elevation	N/A

FID: Flame ionization detector
PID: Photoionization detector
VOC: Volatile Organic Compound
N/A: Not Applicable

- o the firm has knowledge and experience to effect the safe handling and transportation of found ordnance items,

- o the firm has extensive experience with Series 60 EOD publications, and

- o the firm has operatives trained and experienced in accordance with the health and safety requirements for hazardous waste operations of 29 CFR 1910.120.

The UXB operational plan has been provided as Appendix F to the Health and Safety Plan (HASP).

(3) Survey - A survey contractor will establish the horizontal and vertical location for all monitoring wells installed under Delivery Order 001. In addition, existing monitoring and production wells will be surveyed to integrate the installation-wide groundwater monitoring program

5.4.2 Mobilization

The SIs and the RI work will be mobilized at the same time to make efficient use of resources and eliminate duplication of effort. The mobilization will consist of:

- o establishing a temporary field office at Fort Devens to facilitate communications and to serve as a base of operations;

- o coordinating communications with Fort Devens DEH, PAO, EPA Region I, and subcontractors;

- o locating sources of supplies; and

- o staging major equipment to support drilling, geophysical work, field work, and health and safety activities.

After initial mobilization, field work will be continuous through the first major sampling period; when sampling is completed, E & E will fully demobilize. Additional field work, such as water level measurements and the second round of groundwater sampling, will not require extensive field support.

5.4.3 Groundwater Elevation Measurement

The three rounds of groundwater elevations will include the new RI and SI monitoring wells, as well as the existing Fort Devens monitoring and production wells.

Groundwater elevations will be measured to 0.01 foot using an electronic water-level meter. For each round, all monitoring wells in a specified area will be measured on the same day to minimize the effects of temporal fluctuations in groundwater elevations.

5.4.4 Monitoring Well Installation and Development

Following mobilization, seven water table monitoring wells are scheduled for installation in the summer of 1991. Monitoring well installation is expected to be completed within 4 weeks of commencement. For the SI site located on the South Post, monitoring well locations will first need to be cleared of UXO before wells can be installed.

The SI monitoring wells will be installed as follows:

SI SA	NUMBER OF WELLS	APPROXIMATE DEPTH (below ground surface)
EOD	4	35
B202 UST	3	30

All wells will be constructed of 4-inch diameter PVC risers and factory-slotted well screens.

No analytical samples will be collected during drilling. However, samples for classification of soils by the Unified Soil Classification System (USCS) at each monitoring well location will be collected at 5-foot intervals along the length of the boring. Sample collection techniques are described in detail in the SI FSP. Samples will be logged using the USCS, as required by USATHAMA (USATHAMA, 1987), and 10 to 20 percent of the soil samples from each of the nine borings will be submitted for physical materials testing (i.e., grain size distribution, and Atterberg Limits).

Monitoring wells will be installed according to USATHAMA Geotechnical Requirements (USATHAMA, 1987). Field procedures and specific requirements for equipment decontamination (at each well and between borings), well construction, backfilling requirements, cutting and drill fluid disposal are described in the SI FSP. Initially, modified Level D personal protection equipment is recommended for field personnel in the SI field program. Required levels of protection and action levels are described for each site and operation in the HASP.

Well development will proceed no sooner than 48 hours and not later than 7 days after well installation. Wells will be purged using an electric-powered submersible pump and/or bailer. USATHAMA geotechnical requirements are that, during development, at least five times the volume of water standing in the well casing and five times the volume of water added to the well during drilling shall be removed from the well. The turbidity of the water also has to be reduced to the extent practicable. Water cannot be added to aid in development. USATHAMA requires that development data (e.g., static water level, pump specifications, pumping rate, and estimated recharge rate) be recorded at each well site throughout development.

5.4.5 Hydraulic Conductivity Testing

Following well development, aquifer characteristics in the vicinity of each SI monitoring well will be evaluated using hydraulic conductivity testing. Both new monitoring wells and existing wells will be tested. Both rising-head and falling-head water level tests will be conducted, using a pressure transducer and PVC slug. Water level recovery will be recorded with an electronic data logger, as described in the SI FSP. Generally, two to three tests are conducted at each well to establish a representative hydraulic conductivity value.

5.4.6 Unexploded Ordnance Clearing

To clear SIs in the South Post where the potential for UXO exists (based on operational history), UXB will provide qualified UXO personnel onsite to support all activities for the SI work, including site access, geophysical survey, and surface and subsurface sampling.

The UXB team will perform specific clearing procedures that comply with U.S. Army Series 60 Manual procedures for handling ordnance items and will follow current USATHAMA Safety Office guidance. The UXB operations plan is provided as part of the FSP and is included as Appendix F of the HASP. These procedures are summarized as follows:

- provide detailed standard operating procedures (SOPs) for all UXO procedures;
- provide the capability and equipment to communicate with off-site emergency response personnel (cellular and/or radio telephones will probably be used);
- locate, identify, recover/remove, and consolidate all ordnance or energetic items from test pits via surface clearance or sweeping procedures, except for items known or thought to contain chemical agents or ordnance that cannot be safely removed;
- report UXO that cannot be safely removed to the Fort Devens range control for rendering safe and disposing;
- perform geophysical remote sensing surveys, as necessary, to locate subsurface ordnance items; and
- prepare a report summarizing all UXO operations performed during field operations.

5.4.7 Geophysical Measurements

An electromagnetic ground conductivity survey using a Geonics EM31 terrain conductivity meter will be conducted at SA 15. The purpose of this survey is to map and define the extent of trenching and define subsurface anomalies at the site. The results of this survey will be used to assist in locating soil borings.

The EM31 survey will be conducted to detect local anomalies in the subsurface conductivity that may indicate the presence of buried materials and objects.

5.4.8 Surface Soil Sampling

Surface soil samples will be collected from potential source areas at several SIs. Sampling locations were designated by considering the method of the actual or potential release of chemicals. Both analytical and reference surface soil samples up to 1-foot deep will be collected at each sampling location using manual methods (e.g., stainless steel spoons, trowels, spades, and hand augers). At several South Post SAs, proposed surface sampling locations require UXO clearing before sample collection. At SA 26, no preliminary data exist on explosive residues in the soils; therefore, UXB and E & E will collect 6 soil samples for quick turnaround screening by ADL to determine the presence of explosives residues. Results will be available from the laboratory within 24 hours to determine the appropriate level of safety necessary. If greater than five percent explosives are detected, the soils exhibiting the indicating characteristics of odor, staining, or crystallization will not be sampled.

Analytical samples will be collected using QA/QC techniques to ensure that cross-contamination between samples does not occur. Depending on the SI, sample parameters will include analyses for TCL, TAL, TCLP, PCBs/Pesticides, explosives, and TPHC. Section 7.3, Analytical Schedule, includes a table (Table 7-1) that identifies the number and types of samples to be collected during field operations, as well as the analyses to be performed.

5.4.9 Subsurface Soil Sampling

Subsurface soil samples will be collected from Zulu 1 and Zulu 2 where site conditions or past practices indicate a potential for chemicals to have been released to soil beneath the surface or where vertical migration of chemicals is likely. Both analytical and reference subsurface soil samples will be collected from each SA from depths of 5 and 10 feet below ground surface using hand-augers or test pits. A total of 22 locations will be sampled at Zulu 1 and 2. Subsurface soil samples will be analyzed for the same parameters as listed for surface soil samples. As with surface soil sampling, UXO clearing will be required at Zulu Range. All reference subsurface soil samples will be classified according to USCS classification and 10 to 20 percent from each SA will be analyzed for physical parameters to confirm the USCS classification.

Hand augers will be used for collecting samples from the suspected source areas. However, if UXB cannot adequately clear the subsurface of UXO, UXB will excavate test pits. Excavating test pits provides access for UXO clearance and a good means of examining subsurface materials in the vicinity of the source areas. This will enable relatively easy selection of appropriate analytical samples, as compared with subsurface sampling via borings.

5.4.10 Borings

In addition to installation of monitoring wells, soil borings will be drilled at SA 15 to a depth of 25 feet and at SA 48 to a depth of 35 feet. The borings will be drilled using hollow stem auger drilling technique. Split spoon samples will be collected at 2.5-foot intervals at SA 15 and 5-foot intervals at SA 48 and will be analyzed for TCL, TAL, TPHC, and selected TCLP at SA 15, but only TPHC at SA 48. Ten to 20 percent of the samples will be analyzed for geotechnical parameters (e.g., grain size distribution, USCS classification, and Atterberg Limits). Field procedures and specific sampling requirements are described in the SI FSP and conform to USATHAMA geotechnical specifications.

5.4.11 Surface Water/Sediment Sampling

Surface water/sediment sample pairs will be collected from SI 26 where surface water is present to assess whether these wetlands are potential receptors of groundwater contamination or have been contaminated by run-off from the ranges. Collecting a surface water/sediment sampling pair will help to define the partition of contaminants between the soil and water fractions.

Surface water/sediment samples will be collected from the edge of the wetlands that border Zulu 1 and 2. First, the surface water sample will be collected at mid-depth levels in the water column, by directly submerging the sample container. In order to approximate field conditions, the surface water sample will not be filtered prior to analysis. The sediment sample will then be collected at the same location using a steel split-spoon sampler, dredge, or other appropriate device.

5.4.12 Groundwater Sampling

Groundwater sampling and analyses will be performed at SAs 25 and 48. Depending on the contaminants expected at each site, groundwater samples will be analyzed for some or all of the following chemical groups: TCL VOCs, TCL SVOCs, TAL metals, TPHCs, and several common ions (calcium, magnesium, potassium, bicarbonate, chloride sulfate, nitrate and total Kjeldhal nitrogen).

Two rounds of groundwater samples from monitoring wells will be collected and analyzed for the chemical list specific to each SI. E & E considers two rounds of groundwater data necessary to confirm the persistence of chemicals previously detected in the subsurface soils near the SA 48 UST and to establish a representative concentration of chemicals in new wells at SA 25.

All wells will be purged of five well volumes prior to sample collection. Specific procedures for well purging, equipment decontamination and calibration, sample collection, and field measurement of in situ parameters (e.g., pH, specific conductance, dissolved oxygen, and temperature) are described in the QAPjP specifications.

5.4.13 Soil-Gas Survey

A qualitative soil-gas survey is a planned option for SA 15 in order to support the search for trenches. The survey uses a qualitative field screening technique (Level I) to detect any off-gassing. An organic vapor analyzer will be used in the GC mode. Concentrations above background will be mapped with the geophysical data to improve the definition of the boundaries of the disposal areas.

5.4.14 Survey

All new monitoring wells will have their locations and elevations surveyed by a professional surveyor licensed in the Commonwealth of Massachusetts.

Monitoring well locations will be marked on the Fort Devens base maps. Map coordinates will be transferred to the USATHAMA IRDMIS, no later than 30 days following the date of the last well installation, as required by USATHAMA.

5.5 WASTE MANAGEMENT

5.5.1 Decontamination

Sampling methods and equipment have been chosen to minimize decontamination requirements and prevent the possibility of cross-contamination. Non-disposable equipment will be decontaminated between discrete sampling locations. All drilling equipment will be decontaminated prior to drilling, after drilling each monitoring well, and after the completion of all monitoring wells. Specific attention will be given to the drilling assembly and augers. PVC casing and screens will be kept in sealed containers and cleaned with a high pressure washer prior to use.

A temporary decontamination pad will be constructed at Shepley's Hill Landfill using defined perimeter area lined with heavy plastic sheeting to collect decontamination waters and sediments. The primary purpose of the pad will be to decontaminate heavy equipment such as augers and well casings and screens.

All material generated during decontamination procedures, such as protective clothing, plastic sheeting, and decontamination water will be drummed on-site and labeled, if any evidence of contamination is noted, either by visual observation or through OVA screening. The disposal of investigation-derived waste, determined by analytical testing to be hazardous, will be the responsibility of the installation.

5.5.2 Waste Minimization

As part of the RI, a certain amount of waste material will be generated in association with personal protection, sample handling, multimedia sampling, soil boring, well installation, well development, and well purging. The majority of the waste is not hazardous but some equipment will come in contact with media suspected to be contaminated.

Field-generated refuse will be segregated into contaminated and non-contaminated. Contaminated material, though not identified as hazardous, will be triple wrapped in plastic bags and labeled with date, site, and activity. Non-contaminated refuse will be placed in a plastic bag and disposed of as regular trash.

Action levels have been set for the containerization of site-generated liquid and solid wastes. Field monitoring of the extracted material with photoionization devices (PIDs), OVAs, and by visual observations will determine if organic contamination is present. If organic contamination is documented at levels greater than 10 parts per million (ppm) above background, containment of the material will proceed. When no organic contamination is detected, and the material appears native to the immediate area, uncontaminated cuttings, fluids, and sediments will be returned to the local setting.

Investigation-derived wastes exceeding 10 ppm above background will be drummed in 55-gallon (DOT-17E for liquid or DOT-17H for solids) drums and staged in a secured area until analytical results are available and a proper disposal is recommended. The samples will be analyzed for TCLP metals and organics, reactivity, corrosivity, and ignitability. Disposal of all contaminated investigation-derived wastes will be the responsibility of the installation. E & E will be responsible for the disposal of non-contaminated wastes.

5.5.3 Waste Disposal

Any by-products of this field investigation will be transported to the Fort Devens hazardous waste storage facility. For disposable materials, the lid of these drums will be slightly open to allow insertion of organic vapor detector probes to obtain a reading. If the reading is above 10 ppm, the drums will be labeled as hot trash; if readings are 10 ppm or below, the contents of these drums will be emptied and triple bagged for disposal as regular trash. For drill cuttings, a sample will be collected for each of these drums. For well development and purge water, composite samples will be prepared from all the drums from each well. First, a head space analysis test will be conducted in individual drums. Composite samples will be prepared from drums that do not exceed 10 ppm. Drums that fail this criteria cannot be composited and will be analyzed individually. (See the SI Field Sampling Plan for sampling procedures and Appendix A of the HASP for tasks that will be performed in personal protection Level C). If analysis shows contamination, the waste, which is the property of the Fort Devens, must be disposed of as hazardous waste.

5.6 INTERIM FIELD INVESTIGATION REPORT

Following completion of the Phase I Field Investigation Program and the survey of RI and SI monitoring wells, E & E will prepare reports on various field activities. These interim reports will document and compile data generated during field activities. These reports and supporting data will meet the intent of ELIN A014 (Informal Geotechnical Data), by presenting the following data and observations:

- a list of Fort Devens-wide groundwater levels for selected, existing monitoring wells and an updated groundwater surface contour map;
- a summary of investigative methods, and QAPjP and HASP procedures used during monitoring well installation;
- boring logs;
- monitoring well installation diagrams;
- PID/FID meter screening results;
- field observations (e.g., geology, unusual hydrogeologic conditions, and stained soils);
- physical material testing results for 10 to 20 percent of collected subsurface samples;
- hydraulic conductivity test results;
- survey information for the SI wells and the Fort Devens base map updated to include the new wells; and

- o electronic data files (see Section 6.7 for USATHAMA Codes for IRDMIS entry).

5.7 ANALYTICAL PROGRAM

Contaminants previously identified or to be expected at Fort Devens SI SAs represent an extensive range of chemicals. The following subsections contain an overview of the analytical program and the rationale for the selection of particular parameters at specific SIs. The analytical subcontractor, ADL, will be responsible for providing analytical reports to E & E.

5.7.1 Analytical Parameters

The sampling and analytical programs proposed for each SA SI and the procedures selected for chemical analyses are designed to provide analytical data to support the SI DQOs. These data will be used to (1) determine the presence of a release of hazardous chemicals to the environment; (2) conduct a preliminary evaluation of chemical distribution and potential for migration; and (3) decide if conditions at each SA warrant additional investigation, or conclude that no further investigation or action is necessary. The analytical parameters were selected based primarily on information regarding chemicals expected or previously found to be present.

5.7.1.1 Inorganics-Soils

All soil/sediment and solid waste samples, except for those collected at SA 24, will be analyzed for TAL to provide information to evaluate: (1) the inorganics content of the samples compared with expected and/or actual regional background levels; (2) the potential for inorganics to migrate from the SA; and (3) the potential risks posed through direct contact, inhalation, or ingestion of soil and dust.

5.7.1.2 TCLP Organics and Metals

Eleven soil/sediment samples will be extracted by TCLP (as described in 40 CFR 261.24 Appendix II). The TCLP extract will be analyzed for TCL and TAL. The purpose of the TCLP test is to determine if the extract from a sample contains metals at a concentration equal to or greater than the maximum levels specified by USEPA for classifying a waste as hazardous and to simulate leaching that may occur at the SA.

5.7.1.3 Inorganics-Water

For aqueous or liquid samples, TAL analysis will be performed on unfiltered samples collected from surface water bodies and monitoring wells. Inorganics analysis will be conducted on groundwater samples. Analysis of an unfiltered sample will quantify the total inorganics content in the sample, including those in the dissolved phase, and those adsorbed to suspended solids or colloids.

5.7.1.4 Cations and Anions in Groundwater

Cations and anions (i.e., calcium, magnesium, potassium, bicarbonate, nitrate, nitrite, sulfate, chloride, and total nitrogen) will be analyzed in groundwater samples collected from SAs that might have been impacted by landfill leachate, or discharges from other areas suspected of containing these ions. Additionally, the presence of the nitrite or nitrate anion may be present as a result of a release of explosive chemicals; therefore, ions will be analyzed in groundwater samples collected from SAs expected to have explosives present or where further characterization is necessary.

5.7.1.5 TCLP and RCRA Characteristics - Waste Drums

TCLP, ignitability, corrosivity, and reactivity tests will be performed on any material, generated as a result of field activities, with OVA or HNU readings greater than 10 ppm above background readings. The TCLP extract will be analyzed for the 39 hazardous constituents listed in 40 CFR 261. If the waste is determined to be hazardous, E & E will deliver the waste to Fort Devens for appropriate disposal procedures.

5.7.1.6 Organics-Water and Soil

Semi-volatile organic compounds (SVOCs), VOCs, pesticides/PCBs, petroleum hydro carbons, and TOC analyses will be conducted on soil/sediment and water samples collected from areas where these compounds were previously detected or where further characterization is required. Analysis for explosive compounds will be conducted on various soil and water samples collected from SAs where site activities indicate the potential presence of explosives or where further characterization is required.

5.7.2 Quality Assurance/Quality Control

Sampling and analysis of all matrices during the Fort Devens SI will be carried out in accordance with the requirements of the USATHAMA Quality Assurance Program (USATHAMA, January 1990b) and specifications in the Fort Devens QAPjP. Samples will be handled properly and conveyed to the subcontractor laboratory in accordance with specified chain-of-custody (COC) procedures. The QAPjP describes sample management procedures including sample container and preservation requirements, chain-of-custody program protocol and records, and sample tracking and shipping. Data validation will be performed by E & E as discussed in the QAPjP. The Contractor will receive complete QA packages for all samples from the subcontractor laboratory, and will perform an independent review of these data.

During chemical analyses, the subcontractor laboratory QA/QC Coordinator will, on a weekly basis, provide the QA Contractor/Manager with all system and performance audit reports; COC logs; holding time/

extraction analysis reports; batching reports; instrument logs; maintenance and calibration records; and complete analytical QC documentation as submitted to USATHAMA (control charts, method blanks, surrogate recovery, and matrix spike results). Copies of all corrective actions will be supplied to the Contractor for approval. While the subcontractor laboratory provides operational control of the laboratory, the Contractor QA Coordinator/Manager retains ultimate responsibility for data quality.

5.8 DATA MANAGEMENT

Data generated for the Fort Devens SIs will be managed in accordance with USATHAMA data management procedures (USATHAMA, 1988). These data will include chemical analysis results for groundwater, soil/solid waste, and sediment/surface water samples, and geotechnical data from the monitoring well installation, and soil boring data. Analytical data will be entered into IRDMIS by ADL with simultaneous transmission to E & E. ADL will also submit weekly QC reports (Data Item A008) for analysis, as required.

Computerized chemical analysis data will be entered by ADL including the following files: Chemical Groundwater Data file, Chemical Soil Data file, Chemical Sediment Data file, and Chemical Surface Water Data file.

Computerized geotechnical field data will be entered by E & E, including the following files: Geotechnical Map file, Geotechnical Groundwater Stabilized file, Geotechnical Field Drilling file, and Geotechnical Well Construction file.

Data to be entered into the IRDMIS will be coded, reviewed, and entered by E & E and ADL before maximum contract-specific suspense dates. These suspense dates are shown in Table 5-3. Data approval/validation will be performed by USATHAMA Technology Division, Analytical Branch. E & E will receive complete QA packages for all samples from ADL for data validation, and will assist in QA by performing an independent review of a percentage of these data. Additional data validation requirements as required by EPA will be provided in the QAPjP. All original logbooks, model outputs, and hard copy of chemical/geotechnical data will also be supplied.

5.9 DATA EVALUATION

Data collected from investigative activities will be evaluated to determine whether they meet SI DQOs. Data and interpretations will be presented in formats useful for making decisions about SA status (i.e., continue additional investigation, conduct no further action, or scope subsequent field work).

Table 5-3

DATA MANAGEMENT SUSPENSE DATES

Code	Title	Maximum Contract-Specific Suspense Dates*
GMA	Geotechnical Map File; Monitoring Wells	Not later than 14 days following last monitoring well installation
GMA	Geotechnical Map File; Other Sample Types	Not later than 14 days after a sampling event
GGS	Geotechnical, Groundwater Stabilized File	Not later than 7 days following last groundwater elevation measurement
GFD	Geotechnical, Field Drilling File	Not later than 30 days following last monitoring well installation
GWC	Geotechnical, Well Construction File	Not later than 30 days following last monitoring well installation
CGW	Chemical Groundwater Data File	Not later than 40 days after sample collection
CSO	Chemical Soil Data File	Not later than 40 days after sample collection
CSE	Chemical Sediment Data File	Not later than 40 days after sample collection
CSW	Chemical Surface Water Data file	Not later than 40 days after sample collection

*Days are counted as calendar days.

Source: USATHAMA, IRDMIS, 1989

5.10 ARAR IDENTIFICATION

Preliminary action-specific applicable or relevant and appropriate requirements (ARARs) were only briefly addressed for consideration during field activities; however, a more comprehensive evaluation of action-specific ARARs will be made if any of these SAs continue through the RI/FS phase.

Following implementation of the SI technical programs and data evaluation, revised location-specific and chemical-specific ARARs can be established. At that time, site features will have been identified during the field programs and chemical distribution at the SAs will be characterized following receipt of SI analytical data. These revised ARARs and the preliminary action-specific ARARs will be presented in the SI Report. Revision and refining of ARARs will continue through subsequent stages of the CERCLA process.

5.11 SITE INVESTIGATION REPORT

An SI Report, following USEPA guidance, will be prepared for the Fort Devens SI sites, following completion of all SI field activities, data evaluation, and ARARs identification (EPA, 1987). For each SA, the SI Report will describe the work efforts that generated the SI data and will present evaluations and interpretations of these data. In order to revise the conceptual models presented in this Work Plan, the following topics will be addressed, focusing primarily on the new SI data, but taking into account data generated in previous investigations:

- physical setting;
- field investigation program;
- geologic characterization;
- hydrologic/hydrogeologic characterization;
- results of chemical analyses for: source/waste, surface and subsurface soil, sediment/surface water, and groundwater samples;
- preliminary assessment of chemical distribution, fate, and migration pathways;
- preliminary assessment of potential exposure mechanisms and receptors; and
- recommendation.

A Draft, Draft Final, and Final SI Report will be prepared. Each report version will be submitted for review to the USATHAMA COR, Geologist, QA personnel, and Fort Devens. After these comments are addressed, USATHAMA will release the draft final report to USEPA and MDEP for review and comments.

E & E will prepare a separate comment response package to individually respond to regulatory agency comments. Following the agency and USATHAMA review of the Draft Final Report, E & E will prepare a Final Report incorporating all comments and this will be the final deliverable for the SI part of the Delivery Order.

6. PERSONNEL REQUIREMENTS

The Fort Devens SI will be accomplished using a functional task breakdown following the standard SI tasks. The Site Manager will have the primary responsibility for implementing the SI which will include:

- o coordinating the project through key task leaders,
- o assuring that the necessary resources (personnel and equipment) are available,
- o working with the review team leader to assure quality deliverables, and
- o providing continued communication with the USATHAMA Contracting Officer's Technical Representative (COTR).

Continued communication will ensure that USATHAMA receives project information in a timely manner and is updated on the progress of the work on any potential problems that require USATHAMA decisions on changes in project methods or goals.

Figure 6-1 presents the organization structure that E & E will use to manage the SI. Figure 6-1 also indicates the key individuals selected for this project, from the Program Manager through the various team leaders. E & E has identified team leaders in the following functional areas critical to the implementation of this phase of the delivery order: office geologist, community relations, and risk assessment. Key support personnel have been identified in the areas of UXO, field geology, and field safety. Figure 6-1 also identifies, by function, other support personnel who will be used for this phase of the delivery order. In several instances, a single person will perform multiple roles at the site and in the office or simultaneously with the RI/FS.

6.1 PROGRAM MANAGER

The Program Manager for this contract is Mr. Lewis A. Welzel. He is the single point of contact for all work conducted under this contract and is E & E's sole authority for negotiating and committing the firm to the scope of work and level-of-effort. Through the Executive Vice President - Technical Services (G. Strobel, P.E.), the Program Manager is delegated the authority to acquire and marshal corporate resources to support this contract. His responsibilities include:

- o providing the final definition of the work effort;

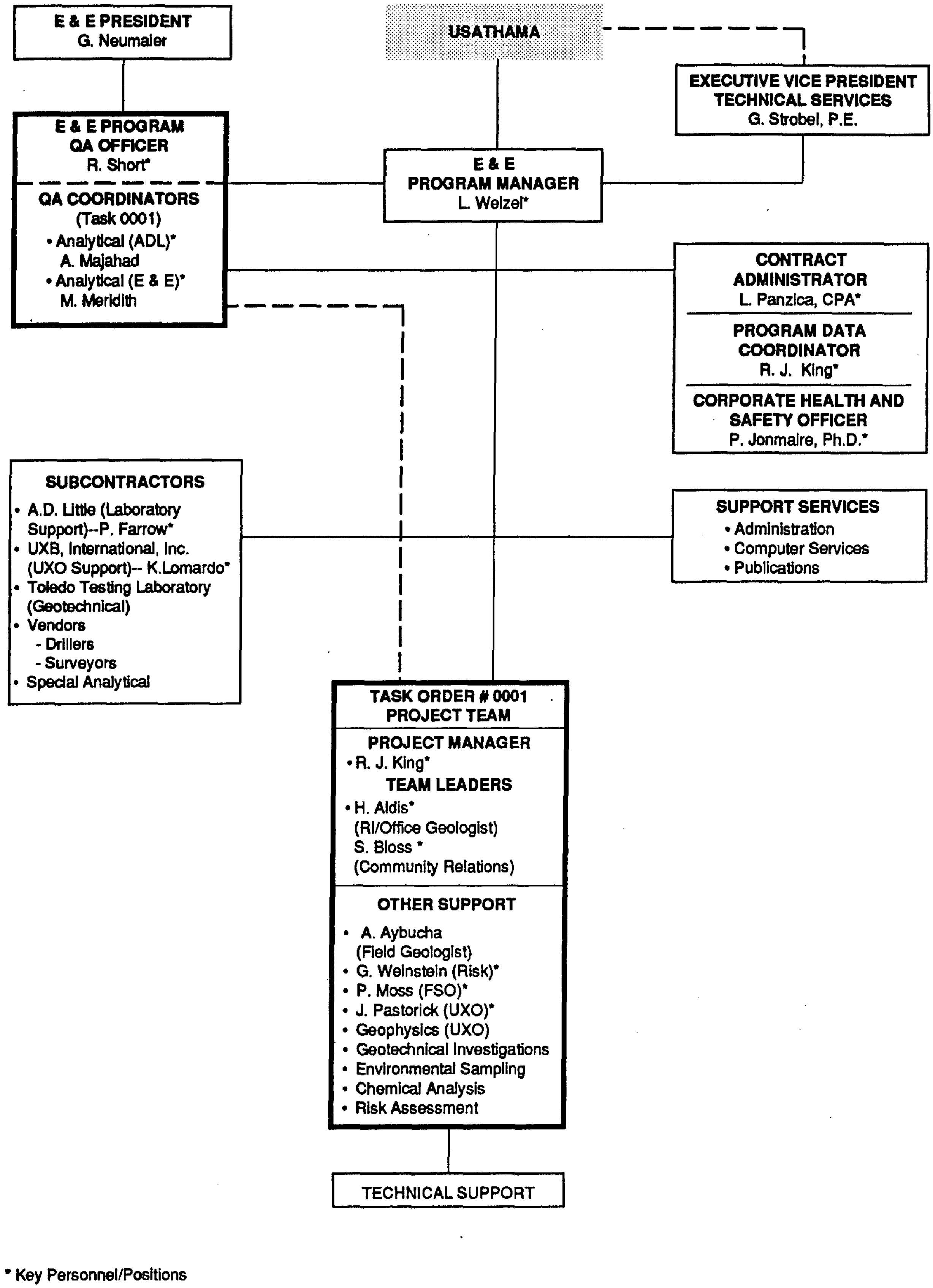


Figure 6-1 PROJECT ORGANIZATION

- o assigning of Project Managers;
- o acquiring/committing resources;
- o assigning responsibilities/authorities;
- o providing cost, time, and technical control of the overall contract; and
- o identifying problems/implementing corrective actions.

With the support of the Contract Administrator, the Program Manager also will conduct negotiations and execute subcontract agreements, supervise the overall contract administration, review delivery order performance, and execute delivery order and overall contract close-out.

6.2 PROJECT MANAGER

The Project Manager for Fort Devens is Mr. Robert J. King. This position is directly subordinate to the Program Manager. The responsibilities of the Project Manager include:

- o supervising daily task-order assignments;
- o assigning resources for optimum work execution;
- o establishing work teams for specific tasks;
- o providing technical liaison with the USATHAMA Contracting Officer/COTR;
- o identifying/resolving technical problems;
- o identifying potential or desired modifications to the scope of work;
- o providing cost, time, and technical performance control and preparing technical presentations;
- o specifying supervising task-order reports; and
- o providing internal liaison with the overall Contract Administrator.

Line authority is assigned to Project Managers by the Program Manager commensurate with the specific scope of work, performance schedule, level of assigned resources, and track record of the individual involved.

6.3 TEAM LEADERS

There will be several specific teams involved with the technical field effort which will be focused on field sampling, monitoring well installation and abandonment, geophysical surveying, and community relations. These team leaders positions are directly subordinate to the Project Manager and are filled on the basis of demonstrated technical expertise. Personnel commonly assigned as team leaders include senior engineers, chemists, and scientists. The team leader is responsible for:

- o supervising daily team activities;
- o directing technical team assignments;
- o scheduling personnel and work assignments;
- o planning team logistics;
- o providing routine briefings for the Project Manager;
- o identifying technical problems and recommending solutions;
- o providing resource accountability; and
- o ensuring product quality within specific areas of expertise.

The authority given a team leader is commensurate with the assigned responsibilities and usually is limited to supervisory authority over team activities within the scope of work assigned and specific areas of expertise. Specific team leader assignments will be made from the corporate personnel pool. The individuals will be designated after the formulation of specific task-order work plans. The team leaders anticipated for the Fort Devens project are designated in Figure 6-1.

6.4 OFFICE GEOLOGIST

Mr. Hussein Aldis has technical responsibility for interpreting geotechnical data in conjunction with the field geologists. The office geologist is also responsible for:

- o reviewing the planning and supervision of the execution of soil, sediment, and hydrogeological investigations;
- o pre-evaluating the literature on the geochemical properties of contaminants, soil, sediments, and formations peculiar to a specific site;
- o interacting with the site geologist in cases where changes in scope of work appear to be warranted;

- o interpreting the results of sampling and analysis activities to determine groundwater flow;
- o keeping the Project Manager and through him, the COTR, informed of significant developments;
- o interacting with project groundwater modelers as appropriate, to determine aquifer and contaminant migration characteristics;
- o consulting with project engineering staff regarding pumping rates and groundwater flow modification to be expected with groundwater capture and treatment methods, if required;
- o preparing calculations for advising the field geologist and project engineering staff on modification to work plans as necessary; and
- o reviewing contract deliverables for quality assurance.

The office geologist will coordinate with other disciplines on the project to guarantee that information is developed to support site assessment and remedial action planning.

6.5 FIELD GEOLOGIST

The functions/responsibilities of the field geologist include:

- o supervising drilling and boring operations;
- o preparing logs for installation of monitoring wells;
- o supervising groundwater, soil, and sediment sampling;
- o planning and scheduling of on-site geotechnical activities;
- o assessing bore samples on-site; and
- o supervising geotechnical input to the data management system.

These duties will be supervised by Mr. Amin Ayubcha and carried out by other staff geologists in order to maintain continuity.

6.6 PROGRAM QUALITY ASSURANCE (QA) OFFICER

This is a permanent position within the functional structure of the company and operates in affiliation with, but outside of, project authority chains. The Program QA Officer, Mr. Russell Short, reports directly to E & E's President and is responsible for planning and executing administrative, laboratory, field, and engineering QA. He also functions in a dual capacity as the Administrative QA Coordinator. The Program QA Officer performs project audits to ensure that contractual, cost accounting, and internal technical/procedural protocol are followed for the completeness of data collection methods, validity of chemical analysis results, and accuracy of engineering drawings and calculations. The chain of authority runs from the Program QA Officer to specifically designated individuals within the operating divisions. These individuals operate in affiliation with, but independent of, the reporting chain within active projects. Other QA Coordinator roles/responsibilities are described below.

6.7 LABORATORY QA COORDINATOR

These are permanent positions operating in both ADL's Chemical and Life Sciences Section and E & E's Analytical Services Center (ASC). The ADL QA Coordinator, Mr. Anthony Majhad, will monitor and execute the analytical QA program. Responsibilities include:

- developing client-specific QA programs;
- introducing QA samples into the sample stream;
- collecting and analyzing QA results;
- identifying out-of-control analytical systems and providing recommendations for corrective actions;
- publishing QA reports;
- reviewing all analytical data prior to release to the client;
- publishing QA Standard Operating Procedures (SOPs);
- accepting and logging all samples;
- providing materials for blanks and spikes to field sampling teams;
- executing periodic QA audits of analytical systems; and
- monitoring analytical certification activities.

The ADL QA Coordinator will report to Ms. Marcia Meredith of E & E, who will report to the Program QA Officer.

6.8 FIELD QA COORDINATOR

This position will be utilized when field sampling or analysis are implemented off-site. This individual reports directly to both Laboratory QA Coordinators. The Field QA Coordinator is responsible for the accuracy and precision of field-generated samples and information. This individual has the authority to impose proper procedures or stop an operation. Duties will be highly dependent on the specific scope of work and tests to be performed.

6.9 CORPORATE HEALTH AND SAFETY OFFICER

This is a permanent position established for policy guidance and routine supervision of corporate safety. Paul Jonmaire, Ph.D., is responsible for:

- o promulgating the corporate safety policy,
- o executing safety audits for projects with a potential for personnel risk,
- o maintaining and controlling E & E's safety equipment,
- o investigating job-related accidents and injuries,
- o assigning subordinate safety officers,
- o reviewing project safety plans, and
- o providing safety training.

The Corporate Health and Safety Officer has the authority to stop an activity for safety reasons if undue risk is found or if corporate or contractual safety practices are abused.

6.10 FIELD SAFETY OFFICER

The Field Safety Officers (FSOs) for Fort Devens are assigned on an as needed basis. This position provides direct safety support for field activities but is directly responsible to the Corporate Health and Safety Officer. The FSO is on-site as a member of the field team, will be supported by UXO experts as needed, and has the authority to stop a field operation if prespecified safety procedures are not followed or if hazards are encountered for which the teams are not prepared. The FSO also is responsible for:

- o instructing all field personnel of site-specific safety procedures;
- o conducting preliminary site surveys to identify the types and degrees of possible risk, instrument sweeps of sites for toxic/hazard emissions;
- o organizing/supervising designated contaminated and uncontaminated areas at a site;
- o establishing decontamination stations or procedures as needed;
- o monitoring sample collection/packaging to ensure compliance with transportation safety regulations;

- o establishing air monitoring stations around a site having the potential for toxic hazardous emissions;
- o modifying and implementing site-specific safety plans and SOPs as required;
- o calibrating monitoring instrumentation; and
- o preparing safety reports.

6.11 CONTRACT ADMINISTRATOR

This position, held by Mr. L. Panzica (CPA), supports the Program Manager and Project Manager in establishing and tracking financial and contractual requirements. The Contract Administrator is responsible for:

- o supervising monthly invoicing,
- o publishing a monthly performance and cost report,
- o collecting and maintaining computerized cost data,
- o identifying work element expenditure variances,
- o reconciling financial variances with the Project Manager,
- o generating exception reports,
- o coordinating administrative procedures with USATHAMA's Contracting Officer, and
- o preparing specified reports to the Contracting Officer for Program Manager review and signature.

The Contract Administrator also will assist the Program Manager in the negotiation and execution of subcontractor agreements.

6.12 PROJECT DATA COORDINATOR

The Project Data Coordinator reports administratively to the Program Manager and functionally to the Project Manager. He is responsible for the flow of data from creation through processing, storage, and retrieval within the parameters of the USATHAMA IRDMIS. He will work closely with internal and USATHAMA-specified automated data system managers and data processing personnel to ensure that all Level 1, 2, and 3 data are accurate and usable within the configuration of the IRDMIS. ADL personnel will serve in this role with oversight provided by E & E.

6.13 SUBCONTRACTOR COORDINATOR

The Subcontractor Coordinator is the single contact and liaison for subcontractor firms regarding all work in support of E & E under this contract. This individual:

- o is authorized to represent his/her company;
- o negotiates subcontract arrangements;
- o commits his/her firm's resources; and
- o has final responsibility for cost, time, and technical performance.

This individual also is responsible for integrating and coordinating the QA and safety requirements specified by E & E as agreed to with USATHAMA. For all delivery orders, each subcontractor is responsible to E & E's Program Manager for contractual obligations and provides direct support to the E & E Project Manager who is using the firm's services.

6.14 SUBCONTRACTORS

E & E will be using three or four subcontractors to support specialized work elements of the first delivery order. UXB International, Inc., (UXB) will provide expert UXO support services for tasks assigned to E & E where UXO may be encountered. ADL, a USATHAMA Certified Laboratory, will provide chemical analysis support services for analytes that the laboratory currently is certified to perform. ADL will perform all of the chemical analyses required for Delivery Order No. 0001, except the air monitoring samples. Toledo Testing Laboratory will perform all of the analyses of the collected geotechnical samples. An additional subcontract will be issued for surveying services.

6.14.1 Laboratory Safety Officer

The ADL Laboratory Safety Officer provides direct support to the laboratory director and laboratory technical staff, but is responsible for the implementation and incident reporting requirements specified in the safety plan. This individual will be at the laboratory facility performing the chemical or reactivity analysis, and will report programmatically to the Corporate Health and Safety Officer. The Laboratory Safety Officer also will be responsible for:

- o planning, directing, and evaluating the laboratory safety programs;
- o assuring that samples that are shock-, friction-, and spark-sensitive are received and stored to avoid chain explosions and reactions; and

- o assuring that proper protective clothing, apparatus, and measures are used by laboratory technicians during chemical characterization of environmental samples.

6.14.2 Laboratory Manager

This position with ADL supports the Program Manager and Project Manager in coordinating the operations or analyses conducted in the laboratory. This person is responsible for:

- o scheduling laboratory work;
- o supervising professional chemists/laboratory analytical equipment operators; and
- o assuring that all analyses are conducted in accordance with accepted parameter methods.

7. SI SCHEDULE

7.1 PROJECT MANAGEMENT SCHEDULE

Figure 7-1 provides a schedule for the completion of all SI tasks under Delivery Order No. 0001.

Figure 7-2 provides a flowchart showing the different project tasks as they apply to the SI phases of the project. E & E will be tracking progress according to these tasks as part of the total project management system.

There are three principal phases of tasks for this delivery order. The first phase involves reviewing existing data and preparing draft technical plans, which are scheduled from October 15, 1990, through July 15, 1991. The second phase, field work (other than the pre-drilling site visit and groundwater sampling), is scheduled for June 3, 1991, through August 15, 1991. The third phase, final report preparation, begins with the field work and continues through October 1992 when the final report is due.

7.2 FIELD SCHEDULE

A focus of field activities to the field work scheduled at the firing ranges in the third week of June 1991. The integration of field tasks with the RI will provide maximum efficiency while minimizing travel and other direct costs. Figure 6-3 highlights the major field activities scheduled for June through August 1991. Two additional rounds of water level measurements and a second round of water samples extend beyond the June through August period. Scheduling of these events are depicted on Figure 7-1, under Task 8.

7.3 ANALYTICAL SCHEDULE

The analytical schedule closely follows the field work schedule. Figure 7-4 and Table 7-1 identify the number and types of samples that will be taken during the field period.

7.4 MODIFICATIONS TO SCHEDULE

When conditions and situations require that the schedule be modified, the Contracting Officer/COTR will be notified of the change, the reasons for the change, and the effect it may have on other schedules. It is hoped that by reserving the firing ranges well in advance, other field work will be flexible and can be scheduled around the range work. E & E believes that the only uncontrollable variables will be severe weather conditions, and perhaps, the international political situation as it might impact Fort Deven's overall mission.

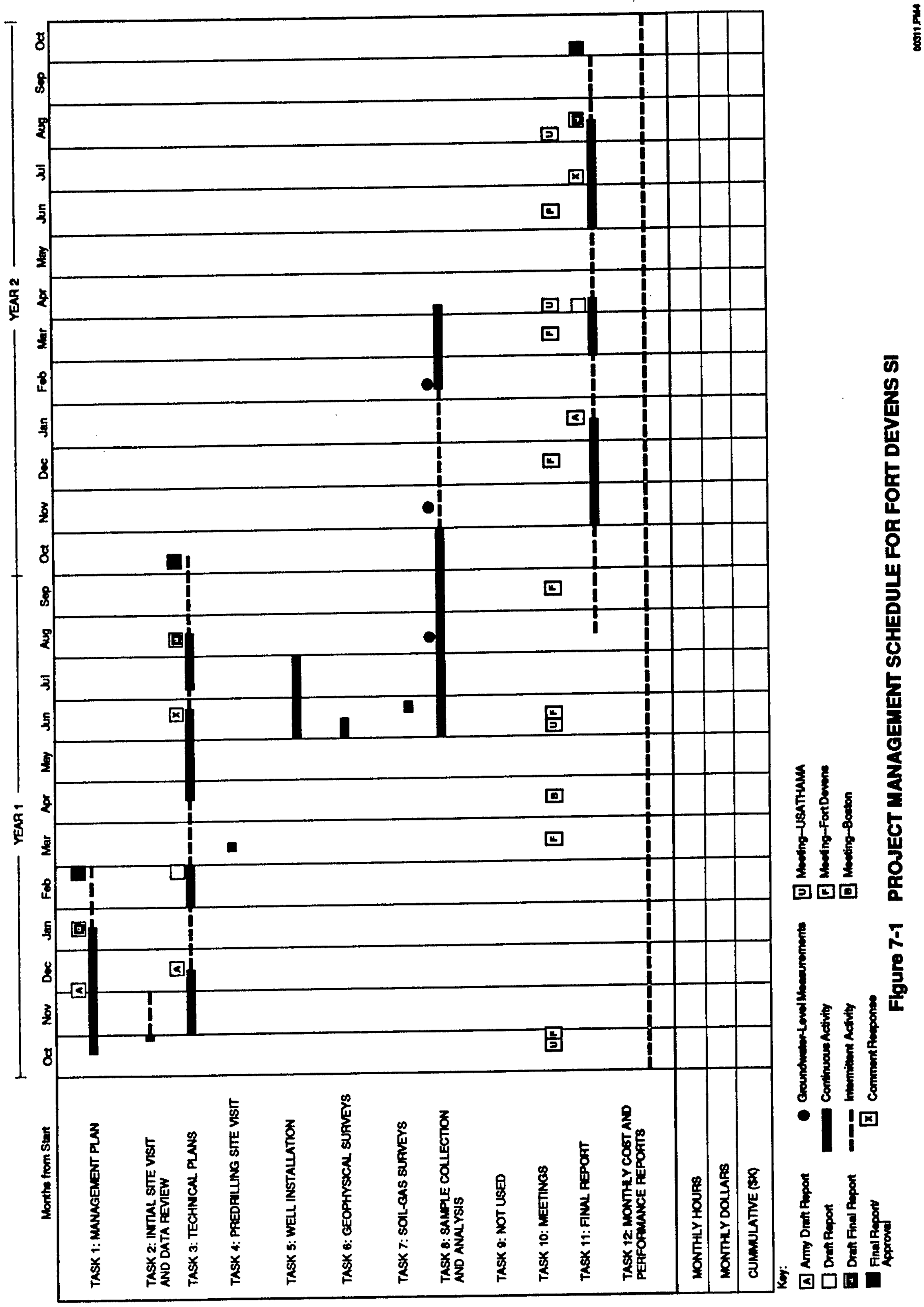


Figure 7-1 PROJECT MANAGEMENT SCHEDULE FOR FORT DEVENS SI

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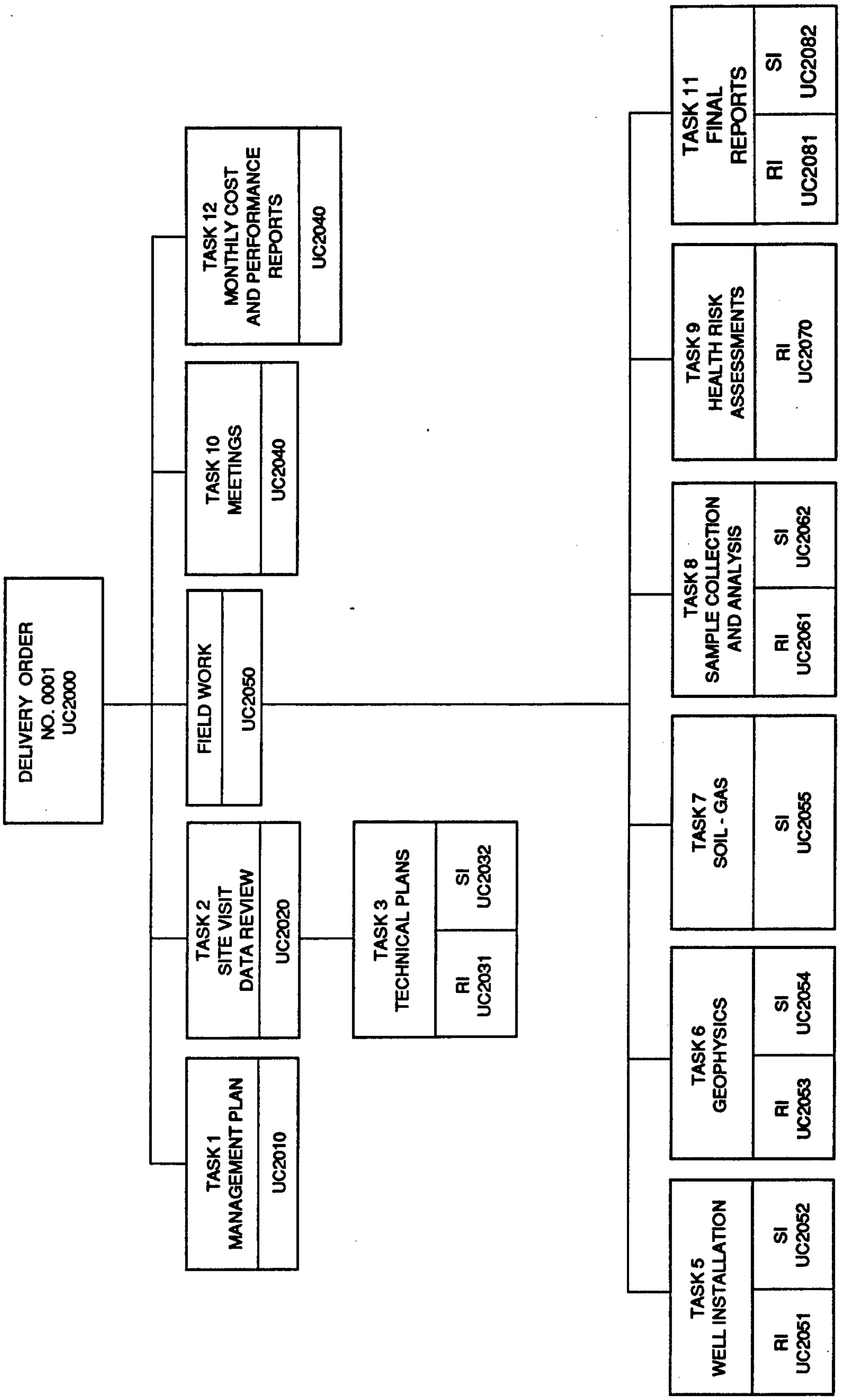

Figure 7-2 FLOWCHART OF PROJECT TASKS FOR FORT DEVENS RI AND SI

June 2 - August 3
FT. DEVENS SI FIELD SCHEDULE

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
June 2	June 3	June 4	June 5	June 6	June 7	June 8
	Geophysical Survey at LF 11					
June 9	June 10	June 11	June 12	June 13	June 14	June 15
June 16	June 17	June 18	June 19	June 20	June 21	June 22
	Install Wells at B202					
June 23	June 24 Collect Soils at Zulu 1 & 2 for Explosives	June 25	June 26	June 27	June 28	June 29
					Soil Gas Survey LF 11	
				Well Installation at EOD		
			Soil Borings at Zulu 1 *			
June 30	July 1	July 2	July 3	July 4	July 5	July 6
	Soil Boring at B202					
Well Installation at EOD						
July 7	July 8	July 9	July 10	July 11	July 12	July 13
	Soil Boring at LF 11 *				Slug Test at EOD and B202	
July 14	July 15	July 16	July 17	July 18	July 19	July 20
				GW Sampling at EOD		
			SW/SE Sampling at Zulu 1 & 2			
Slug Test at EOD and B202						
July 21	July 22	July 23 Sampling DRMO/B202	July 24 Soil Sampling B187	July 25	July 26	July 27
July 28	July 29	July 30	July 31	Aug 1	Aug 2	Aug 3
				Soil Borings at Zulu 2 *		

Key: GW Groundwater Sampling SE Sediment Sampling SW Surface Water Sampling

* Sampling occurs with Soil Boring

Figure 7-3 FIELD SCHEDULE FOR FORT DEVENS SI

June 23 - August 3

FT. DEVENS SI SAMPLING PLAN

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
June 23	June 24 6 SOIL FOR RESIDUAL EXPLOSIVES, ZULU RANGES	June 25	June 26 24 GEOTECH SAMPLES 1 TCLP ZULU 1 12 SOIL TCL,TAL, EXP ZULU 1	June 27 24 GEOTECH SAMPLES 1 TCLP ZULU 1 12 SOIL TCL,TAL, EXP ZULU 1	June 28 24 GEOTECH SAMPLES 1 TCLP ZULU 1 12 SOIL TCL,TAL, EXP ZULU 1	June 29
June 30	July 1	July 2 7 SOIL TPH B-202 7 GEOTECH SAMPLES	July 3	July 4	July 5	July 6
July 7	July 8	July 9 10 GEOTECH SAMPLES 20 SOIL TCL,TAL, TPH LF 11 1 TCLP LF 11	July 10	July 11 2 TCLP, LF 11 10 GEOTECH SAMPLES 20 SOIL TCL,TAL, TPH LF 11	July 12	July 13
July 14	July 15	July 16	July 17 8 SURFACE WATER TCL, TAL,TPH,EXP, HARDNESS ZULU 1 8 SEDIMENT TCL,TAL,EXP, TPH,TOC ZULU 1	July 18 4 G.WATER TCL, TAL,TPH,EXP, IONS EOD 2 S.WATER TCL, TAL,TPH,EXP, HARDNESS ZULU 2 2 SEDIMENT TCL,TAL,TPH, EXP,TOC ZULU 2	July 19	July 20
July 21	July 22	July 23 2 TCLP DRMO YARD 3 GROUND WATER TCL, TAL,TPH,IONS B-202 11 SURFACE SOIL TCL,TAL, TPH DRMO YARD	July 24 1 TCLP B187 5 SURFACE SOIL EXPL B187	July 25	July 26	July 27
July 28	July 29	July 30	July 31	Aug 1	Aug 2 20 GEOTECH SAMPLES 2 TCLP ZULU 2 30 SOIL TCL,TAL, EXP ZULU 2	Aug 3

Figure 7-4 SAMPLING SCHEDULE FOR FORT DEVENS SI

Table 7-1

SUMMARY OF WELLS, SOIL BORINGS, SAMPLES, SAMPLE TYPES, AND ANALYSES[a]
FORT DEVENS SITE INVESTIGATION

Name SA	New Wells	Soil Borings	Water[b] Samples	Surface Water	Surface Sediment	Surface Soil	Subsurface Soil	Analyses (number of samples per analysis)
Landfill 11 SA 15		4					40	TCL Organics & Metals (40) TPHC (40) TCLP Metals & Organics (3)
Bunker 187 SA 24						5		Explosives (5) TCLP Metals & Organics (1)
EOD Range SA 25	4		8					TCL Organics & Metals (8) Explosives (8) Anions & Cations (8)
Zulu Range SA 26		22		10	10	6	66	TCL Organics & Metals (86) Explosives (86) Explosives (6) MOD Extr.[c] TCLP Metals & Organics (5) TPHC (20) O_2, Hardness, TOC (10)
DRMO Yard SA 32						11		TCL Organics & Metals (11) TCLP Metals & Organics (2) TPHC (11)
Bldg. 202 SA 48	3	1	6				7	TCL Organics & Metals (3) TPHC (10)
Totals	7	27	14	10	10	22	113	

a Does not include QA/QC samples
b Includes second round of water samples
c Preliminary screening for explosives at Zulu ranges, modified extraction for qualitative estimates.

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US Army Corps of Engineers

Toxic and Hazardous Materials Agency

Field Sampling Plan Site Investigations

Fort Devens, Massachusetts

February 1992
Contract No. DAAA15-90-D-0012
Delivery Order No. 001
ELIN A004

Prepared for:
Commander
U.S. Army Toxic and
Hazardous Materials Agency
Aberdeen Proving Ground, Maryland 21010-5401

Prepared by:
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Final
THAMA Form 45, 1 Jul 90

UC2032/RC155

FIELD SAMPLING PLAN FOR SITE INVESTIGATIONS AT STUDY AREAS 15, 24, 25, 26, 32, 48

FORT DEVENS, MASSACHUSETTS

Contract No. DAAA15-90-D-0012
Delivery Order No. 0001
ELIN A004

February 1992

Prepared for:

UNITED STATES ARMY TOXIC AND
HAZARDOUS MATERIALS AGENCY
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PREFACE

On 13 May 1991, the United States Department of the Army and United States Environmental Protection Agency finalized and signed a Federal Facility Agreement for the conduct of environmental studies and remediation activities at the Fort Devens Army Installation in Massachusetts. This inter-agency agreement was prepared under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and covers a broad spectrum of environmental restoration activities at Fort Devens. One part of the agreement deals with site inspections (SIs) (also referred to as site investigations) and remedial investigation (RI) activities at several defined locations at Fort Devens. The purpose of the SIs is to evaluate existing data about study areas (SA) to determine the presence of toxic and hazardous materials, or the potential threat to human health and the environment. Wherever contamination is indicated by the historical use of the study area, appropriate samples of soil, sediment, water, and air are collected and analyzed to better determine the extent of the threat posed to human health and welfare, and the environment. If a threat or a significant potential threat is determined to exist, the study area is designated an area of contamination (AOC) and is recommended for the next phase of evaluation, the RI.

The purpose of the RI is to fully characterize a known, contaminated site to determine the extent of contamination and to identify the significance of the hazards posed by the site. The RI requires extensive sampling and monitoring to gain a precise understanding of the site and to allow investigators to collect sufficient information for follow-on recommendations on the best methods to remediate the site.

On 21 September 1990, the United States Army Toxic and Hazardous Materials Agency (USATHAMA), under Contract No. DAAA15-90-D-0012, assigned a delivery order to Ecology and Environment, Inc. (E & E) for the conduct of SIs at six locations and RIs at four areas (three of which are co-located) within Fort Devens. In order to properly conduct work at these sites, E & E developed seven draft plans: the Remedial Investigation Work Plan, the Remedial Investigation Field Sampling Plan, the Site Investigation Work Plan, the Site Investigation Field Sampling Plan, the Health and Safety Plan, the Quality Assurance Project Plan, and the Community Relations Plan. The draft plans were reviewed extensively and comments were received from the Department of the Army (USATHAMA and Fort Devens), EPA Region I, the Massachusetts Department of Environmental Protection, the United States Fish and Wildlife Service, as well as the general public. E & E issued a formal response to these comments on 17 June 1991, and on 19 August, 1991 E & E issued revised Final Draft plans, which were again submitted for review and comment. On 10 October 1991, E & E received comments on the final draft plans from the reviewing agencies. E & E modified the plans in accordance with the comments, and a formal response to the final comments is attached to the transmittal letter for this report.

Concurrent with the revision process, field teams prepared for the field sampling program by drilling necessary monitoring wells, and collecting samples to characterize portions of the areas under investigation. Where feasible and appropriate, the plans have been modified to reflect the actual conditions and actions taken during the early stages of field work.

This part of the final plan is one of seven prepared for the Fort Devens delivery order. Appropriate information is cross-referenced among the plans to ensure a complete and accurate portrayal of planned activities without extensive repetition. The seven plans are grouped into five binder sets: the RI Work Plan and RI Field Sampling Plan, the SI Work Plan and SI Field Sampling Plan, the Community Relations Plan, the Health and Safety Plan, and the Quality Assurance Project Plan.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Government Industrial Hygienists
ADL	Arthur D. Little, Inc.
AIHA	American Industrial Hygiene Association
ANL	Argonne National Laboratory
AOC	Area of Contamination
APR	Air Purifying Respirator
ARAR	Applicable or Relevant and Appropriate Requirement
ASC	Analytical Services Center
ASTM	American Society for Testing and Materials
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHSO	Corporate Health and Safety Officer
CLP	Contract Laboratory Program
CMR	Code of Massachusetts Regulations
COC	chain-of-custody
COTR	Contracting Officer's Technical Representative
CPR	Cardio-Pulmonary Resuscitation
CRC	Community Relations Coordinator
CRL	Certified Reporting Limit
CRP	Community Relations Plan
CVAA	Cold Vapor Atomic Absorption
CWA	Clean Water Act
2,4-D	2,4-dichlororophenoxyacetic acid
CV	Cold vapor
dBA	decibels
DCA	dichloroethane
DCE	dichloroethylene
DDT	dichlorodiphenyltrichloroethane

DEH	Directorate of Engineering and Housing
DERA	Defense Environmental Restoration Account
DIO	Directorate of Industrial Operations
DO	dissolved oxygen
DOD	United States Department of Defense
DOE	United States Department of Energy
DOT	United States Department of Transportation
DPCA	Directorate of Personnel and Community Activities
DQO	Data Quality Objectives
DRMO	Defense Reutilization and Marketing Office
ECD	Electron Capture Detector
E & E	Ecology and Environment, Inc.
EE&G	Environmental Engineering and Geotechnics, Inc.
EOD	Explosive Ordnance Demolition
EP	Extraction Procedure
EPA	United States Environmental Protection Agency
FID	Flame Ionization Detector
FOIA	Freedom of Information Act
FORSCOM	United States Army Forces Command
FR	Federal Register
FS	Feasibility Study
FSO	Field Safety Officer
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Gas Furnace Atomic Adsorption
HASP	Health and Safety Plan
HEPA	High Efficiency Particulate Absolute
HMX	cyclotetramethylene tetranitramine
HNU	HNU Inc., Manufacturer of Photoionization Detector
HPLC	High-Performance Liquid Chromatography
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendments
IAG	Inter-Agency Agreement
ICP	Inductively Coupled Argon Plasma Spectrometry

IDLH	Immediately Dangerous to Life and Health
IR	Installation Restoration
IRDMIS	Installation Restoration Data Management Information System
IRP	Installation Restoration Program
IT	International Technologies Corporation
KO	Contracting Officer
LCL	Lower Control Limit
LEL	Lower Explosive Limit
LOF	Lack of fit
LWL	Lower Warning Limit
MAAF	Moore Army Airfield
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDEP	Massachusetts Department of Environmental Protection
MDWPC	Massachusetts Division of Water Pollution Control
MEP	Master Environmental Plan
MGL	Massachusetts General Law
MS	Mass Spectrometry
MSA	Mine Safety Association
MSDS	Material Safety Data Sheet
MINIRAM	Miniature Real-Time Aerosol Monitor
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSHA	Mine Safety and Health Administration
MSL	Mean Sea Level
NA	Not Analyzed
ND	Not Detected
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
No.	Number
NPDES	National Pollutant Discharge Elimination Systems
NPL	National Priorities List
NRWA	Nashua River Watershed Association
OCLL	Office of the Chief of Legislative Liaison
OCPA	Office of the Chief of Public Affairs

OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Detector
PA	Preliminary Assessment
PAO	Public Affairs Office
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
POL	Petroleum, Oil, and Lubricant
PP	Proposed Plan
PPE	Personal Protective Equipment
PPM	Parts Per Million
PRI	Potomac Research, Inc.
PSI	Pounds Per Square Inch
PVC	Polyvinyl Chloride
QAPjP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	hexahydro-1,3,5,-trinitro-1,3,4-triazine
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPD	Relative Percent Difference
RPM	Remedial Project Manager
SA	Study Area
SARA	Superfund Amendments and Reauthorization Act of 1986
SAS	Special Analytical Services
SCBA	Self-Contained Breathing Apparatus
SDVB	Styrene/Divinylbenzene
SDWA	Safe Drinking Water Act
SI	Site Investigation
SOP	Standard Operating Procedure

SOW	Statement of Work
SSHC	Site Safety and Health Coordinator
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit (Replaced by AOC or SA in these plans)
TAG	Technical Assistance Grant
TAL	Target Analyte List
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TKN	Total Kjeldhal Nitrogen
TLD	Thermoluminescent Dosimeter
TNT	Trinitrotoluene
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TPHC	Total Petroleum Hydrocarbons
TRC	Technical Review Committee
TSCA	Toxic Substances Control Act
TSDA	Temporary Storage and Disposal Area
TSS	Total Suspended Solids
UCL	Upper Control Limit
USACE	United States Army Corps of Engineers
USAEHA	United States Army Environmental Hygiene Agency
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	Underground Storage Tank
UV	Ultraviolet
UWL	Upper Warning Limit
UXB	UXB International, Inc.
UXO	Unexploded Ordnance
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

WWTP	Wastewater Treatment Plant
ZI	Zero Intercept

UNITS OF MEASURE

Btu	British thermal unit(s)
°C	degree(s) Celsius
cfs	cubic feet per second
cm	centimeter(s)
d	day
°F	degree(s) Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
gal	gallon(s)
g	gram(s)
gpm	gallons per minute
h	hour(s)
in.	inch(es)
l	liter(s)
lb	pound(s)
m	meter(s)
mg	milligram(s)
mi	mile(s)
min	minute(s)
mo	month(s)
ppb	part(s) per billion
ppm	part(s) per million
s	second(s)
ton	short ton(s) (i.e. 2000 pounds)
wk	week(s)
yd^3	cubic yard(s)
yr	year(s)
µg	microgram(s)
µmho	micromho(s)

1. INTRODUCTION

Ecology and Environment, Inc. (E & E), under U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) Contract No. DAAA15-90-D-0012, Delivery Order No. 0001, has been tasked to perform Site Investigations (SIs) at six study areas (SAs) located within Fort Devens, Massachusetts (Figure 1-1). E & E has developed this Field Sampling Plan (FSP), a Work Plan, a Health and Safety Plan (HASP), a Community Relations Plan (CRP), and a Quality Assurance Project Plan (QAPjP) for conducting the field SI at Fort Devens. The objectives of the SIs include the classification of each SA into one of several possible categories including:

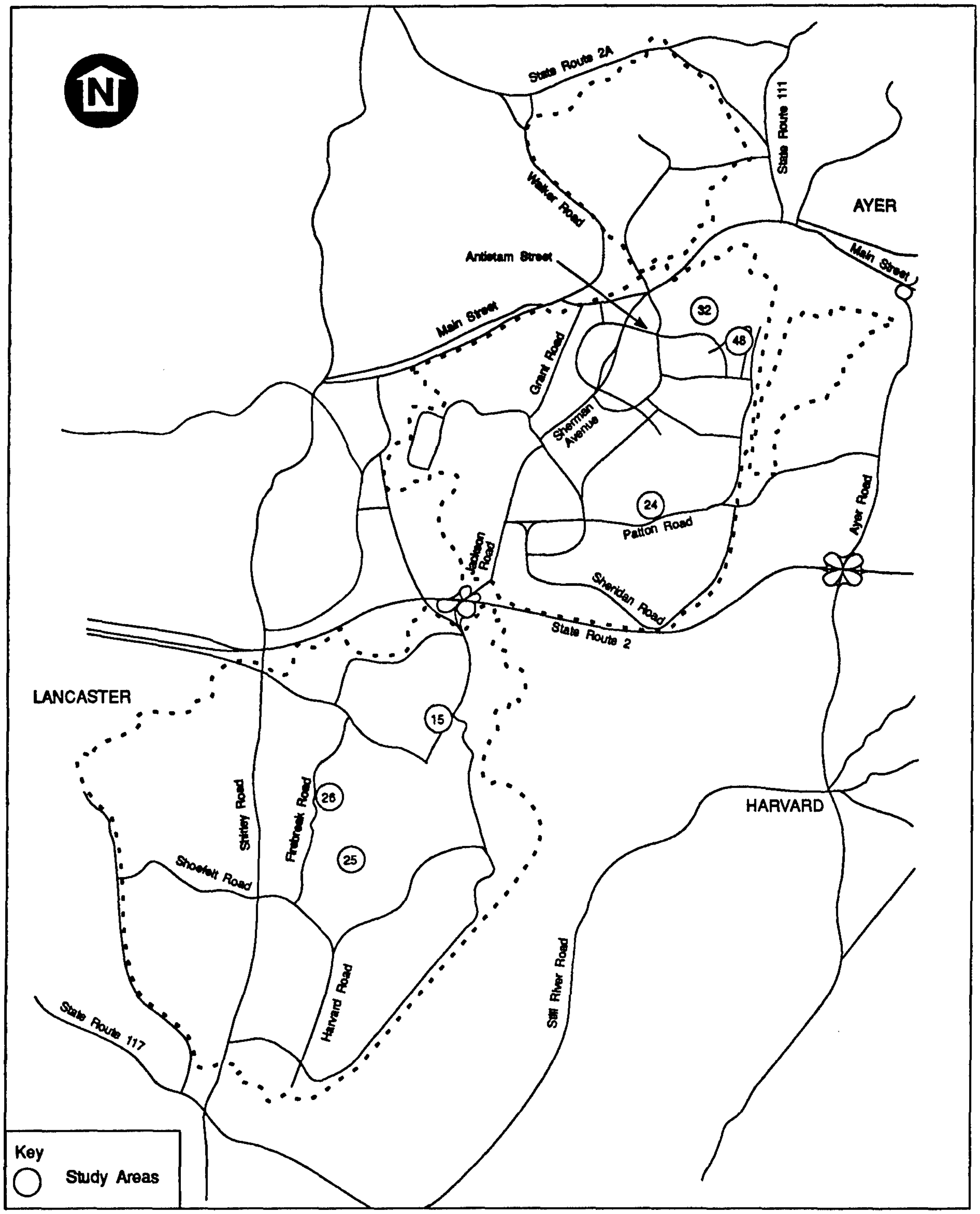
- o sites of no further concern, no further action is necessary;
- o sites requiring immediate remedial measures;
- o sites requiring additional study to fill data gaps and to determine if sites warrant a full-scale Remedial Investigation/Feasibility Study (RI/FS); and
- o sites having sufficient data from the SI to determine that an RI/FS is required.

SIs are to be performed at the following sites:

- o SA 15, also referred to as Landfill No. 11;
- o SA 24, a waste explosives storage area at Bunker 187;
- o SA 25, the waste explosive detonation area of the Explosives Ordnance Demolition (EOD) Range;
- o SA 26, explosives training and detonation areas Zulu 1 and 2;
- o SA 32, the Defense Reutilization and Marketing Office (DRMO) storage yard; and
- o SA 48, the underground storage tank (UST) leak at Building 202.

As part of the background data gathering process, E & E conducted a site visit to each SA in October 1990. At three sites (SAs 15, 25, and 48), contamination was already known to exist as the result of earlier studies. The remaining three sites had little or no sampling history.

The FSP is divided into eight major sections. Section 2 describes the work to be performed in general terms. Section 3 describes the detailed methods to be used in the field for geophysics, the soil-gas survey, well installation, and the various kinds of sampling. Section 4



Source: Interagency Agreement USEPA / USATHAMA

Legend
——— Road
– – – Installation Boundary

Scale in miles
1 3/4 1/2 1/4 0 1

Figure 1-1 LOCATION OF SITE INVESTIGATION SITES AT FORT DEVENS, MA

describes preparations required before sampling. Sections 5 and 6 describe field personnel and site management, and Sections 7 and 8 describe sample handling, packaging and shipping, and sample custody procedures.

Before writing this SI FSP, E & E reviewed the following data:

- o historical aerial photographs;
- o U.S. Geological Survey (USGS) topographic maps, water supply papers, open file reports;
- o documents at the Fort Devens Environmental Office, including reports on previous environmental investigations, regional geology and hydrology, and State of Massachusetts regulations.

E & E also consulted the Interagency Federal Facilities agreement for environmental restoration at Fort Devens, as well as applicable U.S. Environmental Protection Agency (EPA) guidance for the conduct of site investigations.

2. FIELD PROGRAM

The field program is divided into five sections: the initial field activities, which are pre-sampling activities at SA 15; the drilling program, including all boreholes and wells; the sampling and analysis program, detailing the location, number, and type of samples and analyses; the aquifer response tests, discussing slug tests on all new monitoring wells; and the sampling program.

2.1 INITIAL FIELD ACTIVITIES

Initial field activity at SA 15 will include a non-intrusive geophysical survey and, if necessary, a soil-gas survey. The results of these surveys will be used to select soil boring locations.

2.1.1 Geophysical Survey

A geophysical survey using a Geonic EM-31 electromagnetic terrain conductivity meter is planned to support SI activities at SA 15. The exact locations of the pits in which fuel oil was burned at this site are not known. If no definitive location is identified, an electromagnetic conductivity survey will be employed. This survey will identify variations in the normal background reading of electromagnetic conductivity in the soil caused by trench and fill operations. If isolated target areas are identified, the anomalous areas will be followed up with a qualitative soil-gas survey.

2.1.2 Soil-Gas Survey

After identification of suspected disposal areas by aerial photograph interpretation, and/or geophysical survey, the subsurface soil gas above the suspected disposal areas will be monitored with a Century Systems Model 128 Organic Vapor Analyzer (OVA) using the procedures described in Section 3-2. This method has been successfully used at other burn pit sites to qualitatively identity sites of volatile emissions from fuel residues. If the OVA survey does not identify any organic vapors in the soil gas, and targets have not been identified, a further, more sensitive soil-gas survey will be performed using a portable gas chromatograph in the field.

2.2 DRILLING PROGRAM

Drilling activities include investigations of subsurface soil conditions at three SIs and the installation of groundwater monitoring wells on two of the SI sites. The following sections describe the type and quantity of activities scheduled. A total of 7 overburden groundwater wells and 27 soil borings are proposed. Overburden wells will range in depth from approximately 20 feet to approximately 45 feet. Final well depths, locations, and the quantity of wells planned for installation will be based on the site reconnaissance, a review of existing data, and field conditions during drilling. Any field changes could be made only with the approval of USATHAMA.

E & E will employ UXB International, Inc., of Chantilly, Virginia, an ordnance safety contractor, to clear sampling areas before conducting any intrusive activities at SAs 25 (EOD) and 26 (Zulu 1 and 2). For a more complete description of the procedure to be employed, see Section 3.1.2.

Subsurface soil samples will be collected from borings at three of the SI sites: SAs 15, 26, and 48. Twenty-two 10-foot soil borings at SA 26 will be performed by hand auger and backhoe; four borings at SA 15 and one boring at SA 48 will be performed using the drill rig.

2.2.1 Soil Borings

At SA 15, four 25-foot-deep boreholes will be drilled and 40 soil samples collected at 2.5-foot intervals. At SA 48, seven soil samples will be collected at 5-foot intervals over a depth of 35 feet.

At SA 26 (Zulu 1 and 2), a site access grid will be cleared by UXB and a backhoe will be used to excavate areas prior to sampling. The Zulu 1 Range will have 12 areas and Zulu 2 will have 10 areas. A soil bucket auger will be used to collect samples at 3 depth intervals: 0 to 1 feet, 4.5 to 5.5 feet, and 9 to 10 feet. This sampling effort will encompass a total of 66 soil samples at 22 locations.

2.2.2 Well Installation

The wells will be installed following USATHAMA Geotechnical Guidelines for well installation and development.

Four wells will be located at SA 25 (Figure 2-1) and three at SA 48 (Figure 2-2). The proposed wells will be located in and around the perimeter of the site or SA. There are no existing wells associated with these sites although two of the existing Shepley's Hill Landfill wells, (SHL-6 and SHL-12), are near Building 202. The precise locations of the proposed wells will be decided during the pre-drilling site visit; adjustment based on access or hazardous subsurface conditions may be necessary.

Seven proposed groundwater monitoring wells, each approximately 30-feet deep, will be used to determine groundwater quality information across the sites, to evaluate potential downgradient migration of contaminants, and to verify the groundwater flow direction. The well locations will allow further assessment of groundwater quality in both downgradient and upgradient areas of the site (see Section 3.3).

No analytical soil samples are scheduled to be taken from the boreholes since all wells are to be located outside known contamination areas. The boreholes and split spoons will be monitored during drilling with an OVA, and lithologic samples that will be collected every 5 feet

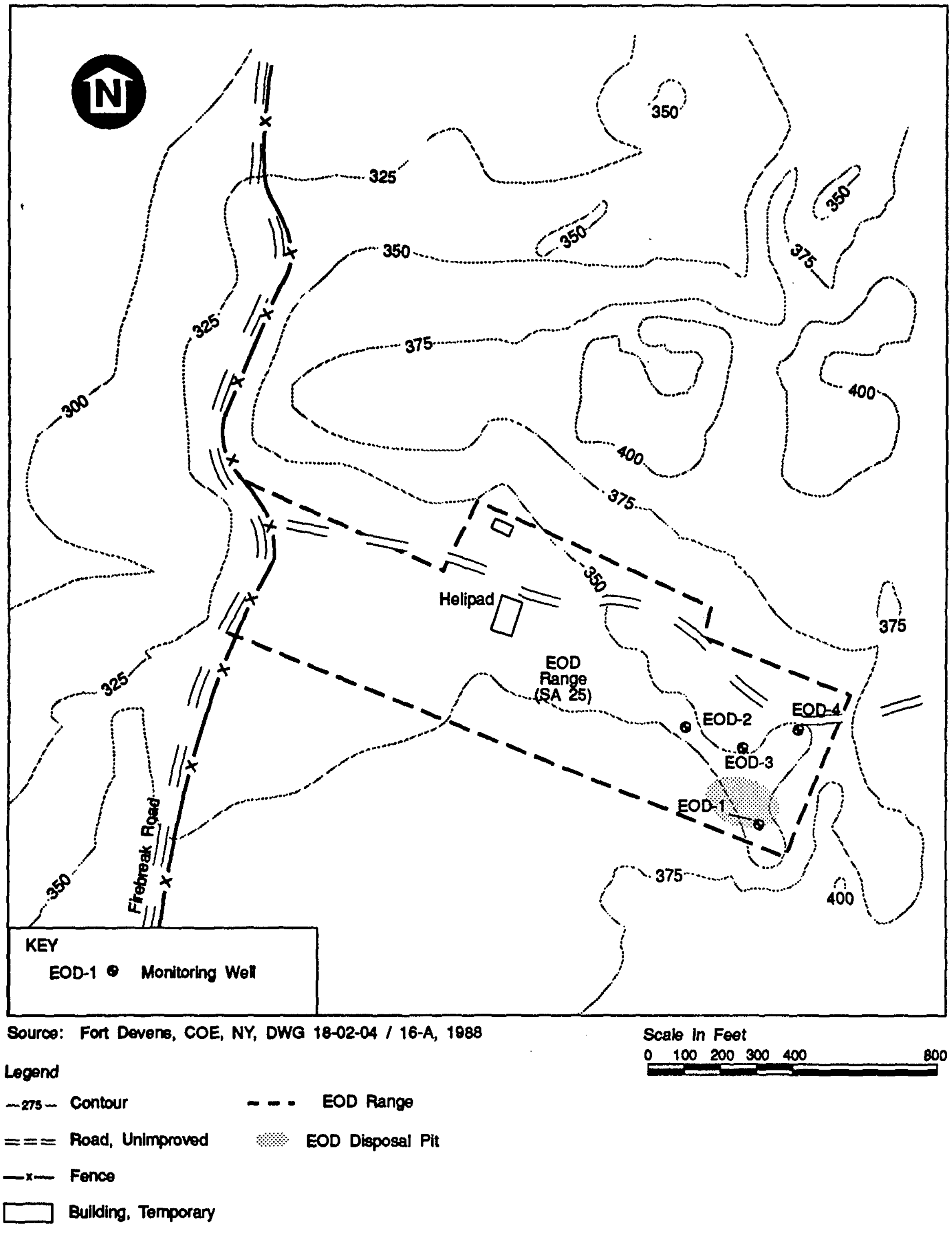


Figure 2-1 MONITORING WELL LOCATIONS AT STUDY AREA 25 (EOD RANGE)

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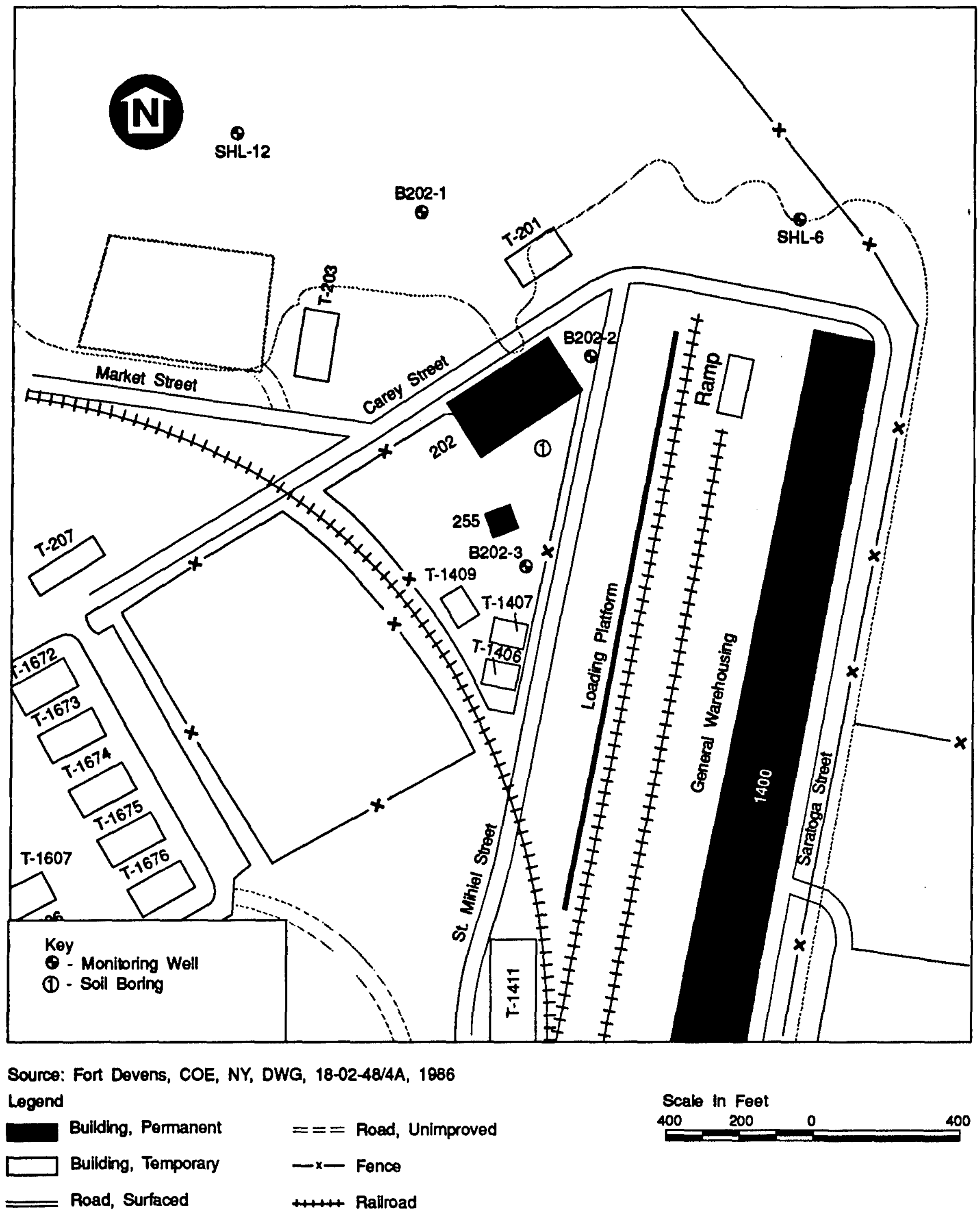


Figure 2-2 MONITORING WELL LOCATIONS AT STUDY AREA 48 (BUILDING 202)

will be recorded on the boring log sheet. A headspace analysis with the OVA will be performed on all lithologic samples. The monitoring wells will be sampled as described in Section 3.5.

2.3 SAMPLING LOCATIONS AND ANALYSIS PROGRAM

The SI will include sample collection from on-site and off-site locations to determine the absence or presence of contamination. The types of samples and measurements proposed for the SI include:

- o surface and subsurface soil sampling,
- o surface water and sediment sample collection from wetlands,
- o geotechnical samples,
- o groundwater samples,
- o field quality control (QC) samples, and
- o water level measurements and hydraulic conductivity testing of the monitoring wells.

Data needs and sampling rationale are summarized in Table 2-1.

2.3.1 Soil Samples

Soil samples will be of two general types: surface soils, collected within the first foot of the surface; and subsurface soils, collected across an interval of depth within a borehole.

2.3.1.1 Surface Soil Samples

At SA 24 (Bunker 187), five surface soil samples will be collected from the perimeter outside the bunker and analyzed. Sampling inside the bunker will not be necessary because the goal is to determine if explosive material or residue exists outside the bunker. Actual sampling locations depend upon observations made at the time of sampling; however, a generalized diagram of sampling locations is presented in Figure 2-3. The five samples will be analyzed for explosives and one sample will be selected for toxicity characteristic leaching procedure (TCLP) metals and organics analysis. Table 2-2 details the sampling scheme for this site.

At SA 32 (DRMO Yard), 11 surface soil samples will be collected from the perimeter of the yard. Actual sampling locations are again dependent on field conditions at the time of sampling; however, a generalized sampling map focusing on low areas, surface run-off pathways, and areas of segregated waste types is presented in Figure 2-4. The 11 samples will be analyzed for Target Compound List (TCL) organics, Target Analyte List (TAL) metals, and total petroleum

Table 2-1

DATA NEEDS AND SAMPLING RATIONALE

Medium	Data Needs and Objectives	Sampling Rationale and Procedure
Surface soils	Evaluate present and potential effects of site activities on surface soils.	Sample for presence of contaminants around: -SA 24 (Bunker 187) and around and within: -SA 32 (DRMO Yard)
Subsurface soils	Evaluate present and potential effects of contaminant migration in subsurface soils.	Sample subsurface soils from boreholes at: -SA 15 (Landfill No. 11) -SA 26 (Zulu Ranges) -SA 48 Building 202 UST area.
Surface water/ sediments	Characterize the nature and extent of contaminant migration off-site to the immediately-adjacent wetlands.	Sample wetlands adjacent to Zulu Ranges for surface water and sediment.
Groundwater	Determine the concentration of contaminants in groundwater beneath the site, and rate and direction of groundwater flow.	Installed monitoring wells at the EOD Range and Building 202 to sample groundwater quality, and to measure hydraulic gradients and aquifer characteristics.

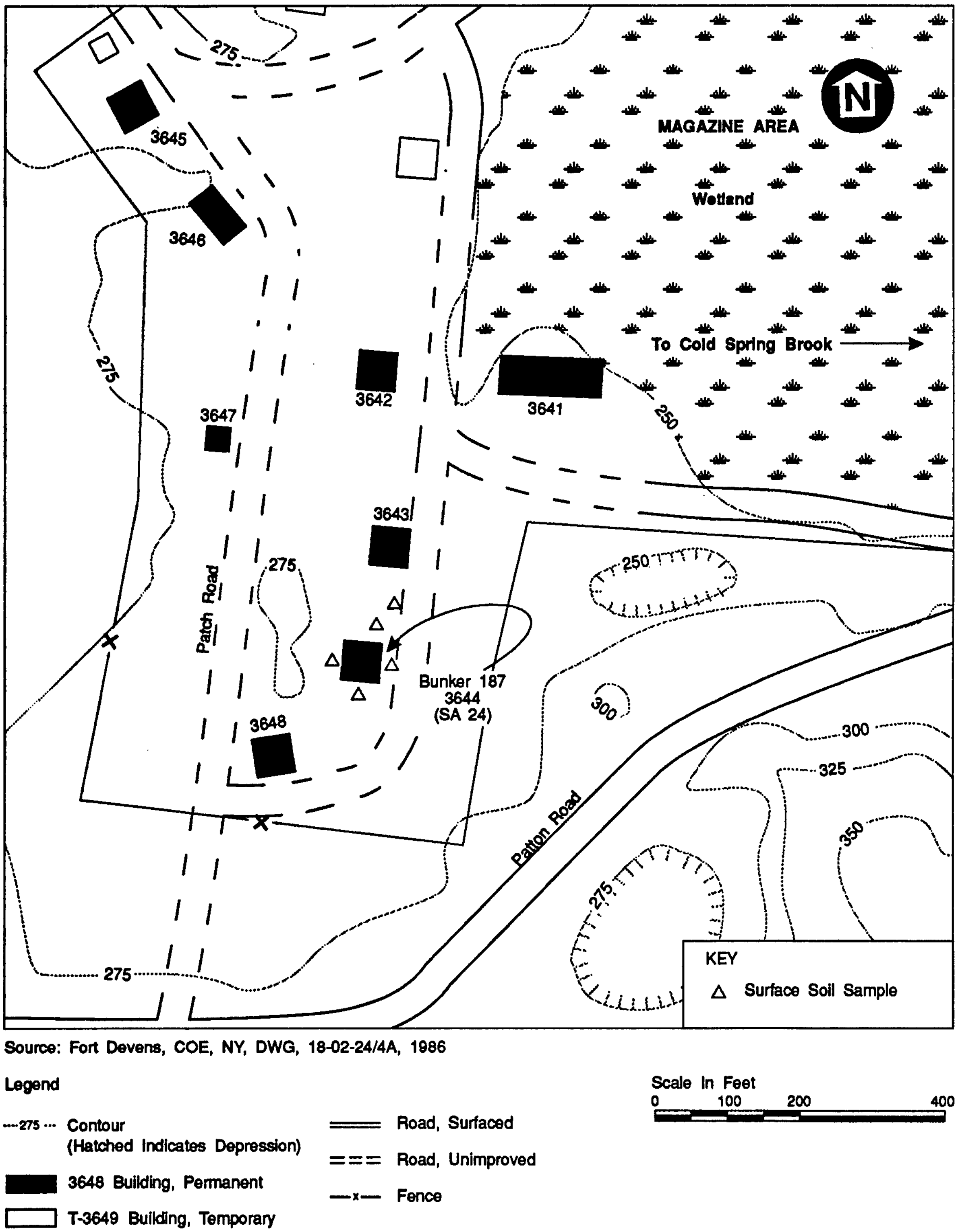


Figure 2-3 SAMPLING LOCATIONS AT STUDY AREA 24 (BUNKER 187)

Table 2-2

SAMPLE SCHEME FOR SA 24 (BUNKER 187)*

SITE TYPE	SITE ID	ANALYSIS
AREA	B187-1	Explosives
AREA	B187-2	Explosives
AREA	B187-3	Explosives
AREA	B187-4	Explosives
AREA	B187-5	Explosives, TCLP Metals/Organics

TCLP: Toxicity Charateristic Leaching Procedure

*Refer to Table 2-8 for QA/QC samples

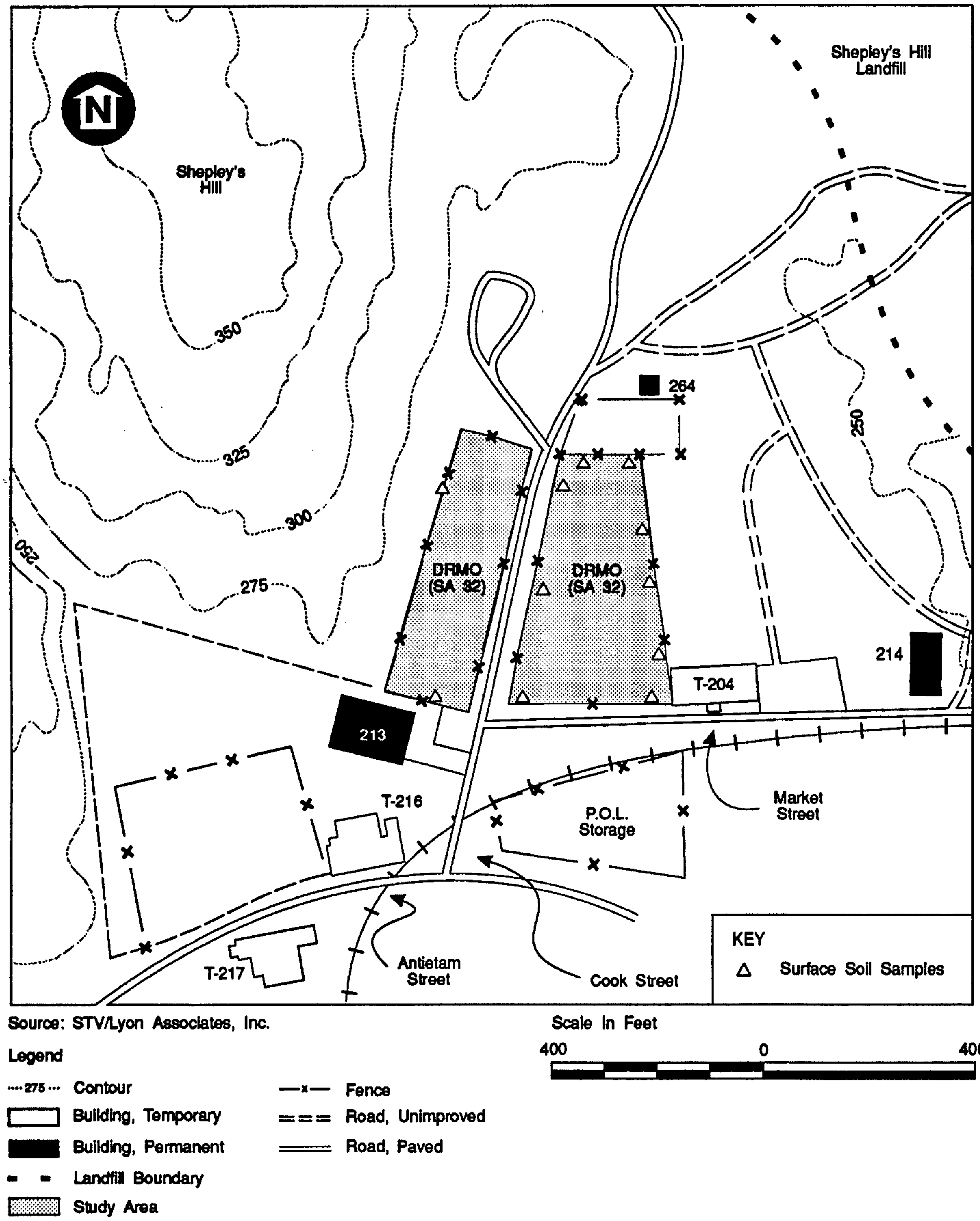


Figure 2-4 SAMPLING LOCATIONS AT STUDY AREA 32 (DRMO YARD)

hydrocarbon (TPHC). Two samples will be analyzed by the TCLP for metals and organics. Table 2-3 details the sampling scheme for this site.

2.3.1.2 Subsurface Soil Samples

At SA 15 (Landfill No. 11), 40 subsurface soil samples will be collected from the four 25-foot deep soil borings. The sampling interval is 2.5 feet; therefore, 10 soil samples will be collected from each hole. Approximate borehole locations of the proposed soil samples are indicated on Figure 2-5. These borehole locations will be selected so that they intersect the locations of the trench(s) to the extent that they can be identified from visual observations made in the field, aerial photographs, geophysical anomalies, or during the soil-gas survey. The 40 samples will be analyzed for TCL organics, TAL metals, and TPHC. Three samples will be selected for TCLP metals and organics analysis. Table 2-4 details the sampling scheme for this site.

At SA 26 (Zulu Ranges), the 66 soil samples will be split between Zulu 1 and Zulu 2. A total of 12 soil borings and 36 soil samples will be collected from Zulu 1 (Figure 2-6A). The remaining 10 borings and 30 soil samples will be further split between the two grenade pits of Zulu 2 (Figure 2-6B). The sampling depth intervals are: 0 to 1 feet, 4.5 to 5.5 feet, and 9 to 10 feet. Actual field sampling locations will require clearance from UXB at the time of sampling. The 66 soil samples will be analyzed for TCL organics, TAL metals, and explosives. Five samples will be selected for TCLP metals and organics. Tables 2-5A and 2-5B detail the sampling scheme for this site.

At SA 48 (Building 202), seven subsurface soil samples will be collected at approximately 5-foot intervals from a single 35-foot-deep soil boring. The soil boring is distinct from the three groundwater monitoring wells scheduled for this site. The actual sampling location will be determined in the field based on accessibility to the known contamination area, and overall safety to the drillers. Figure 2-2 illustrates the sampling scheme for this site. The seven soil samples will be analyzed for TPHC alone since the source of contamination is known. Table 2-6 details the sampling scheme for this site.

2.3.2 Surface Water/Sediment Samples

This category of samples consists of two separate samples from two different media at the same sample point, water and saturated sediment. The water sample is collected first in containers and volumes appropriate for the analysis to be performed as required in the QAPjP. The sediment is collected next from the same location. This category of samples will be collected only from SA 26.

Table 2-3

SAMPLE SCHEME FOR SA 32 (DRMO YARD)*

SITE TYPE	SITE ID	ANALYSIS
AREA	DRMO-01	TCL, TAL, TPHC
AREA	DRMO-02	TCL, TAL, TPHC
AREA	DRMO-03	TCL, TAL, TPHC
AREA	DRMO-04	TCL, TAL, TPHC
AREA	DRMO-05	TCL, TAL, TPHC
AREA	DRMO-06	TCL, TAL, TPHC
AREA	DRMO-07	TCL, TAL, TPHC, TCLP Metals/Organics
AREA	DRMO-08	TCL, TAL, TPHC
AREA	DRMO-09	TCL, TAL, TPHC
AREA	DRMO-10	TCL, TAL, TPHC
AREA	DRMO-11	TCL, TAL, TPHC, TCLP Metals/Organics

TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons
TCLP: Toxicity Characteristic Leaching Procedure

*Refer to Table 2-8 for QA/QC samples

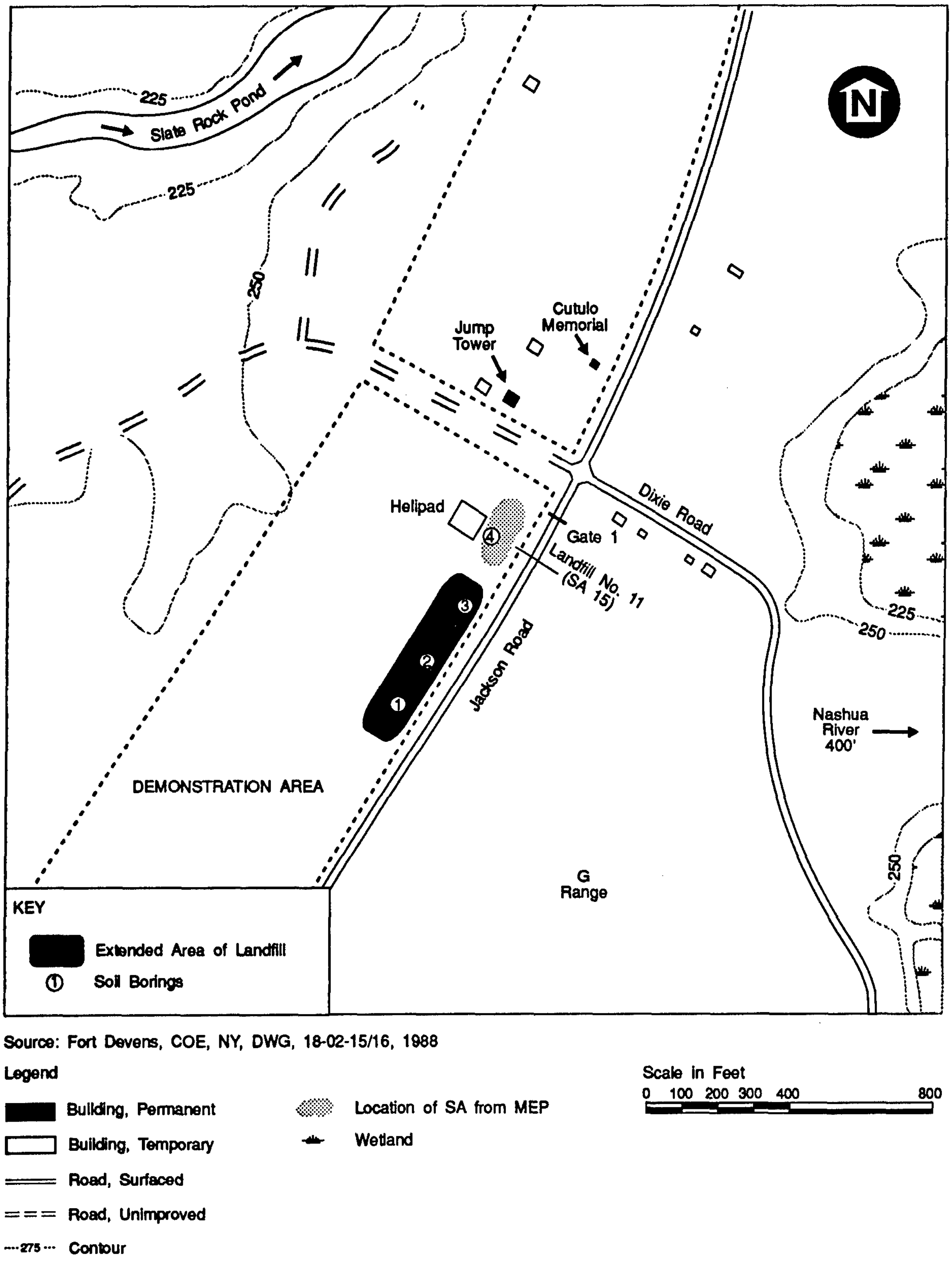


Figure 2-5 BOREHOLE SAMPLING LOCATIONS AT STUDY AREA 15 (LANDFILL NUMBER 11)

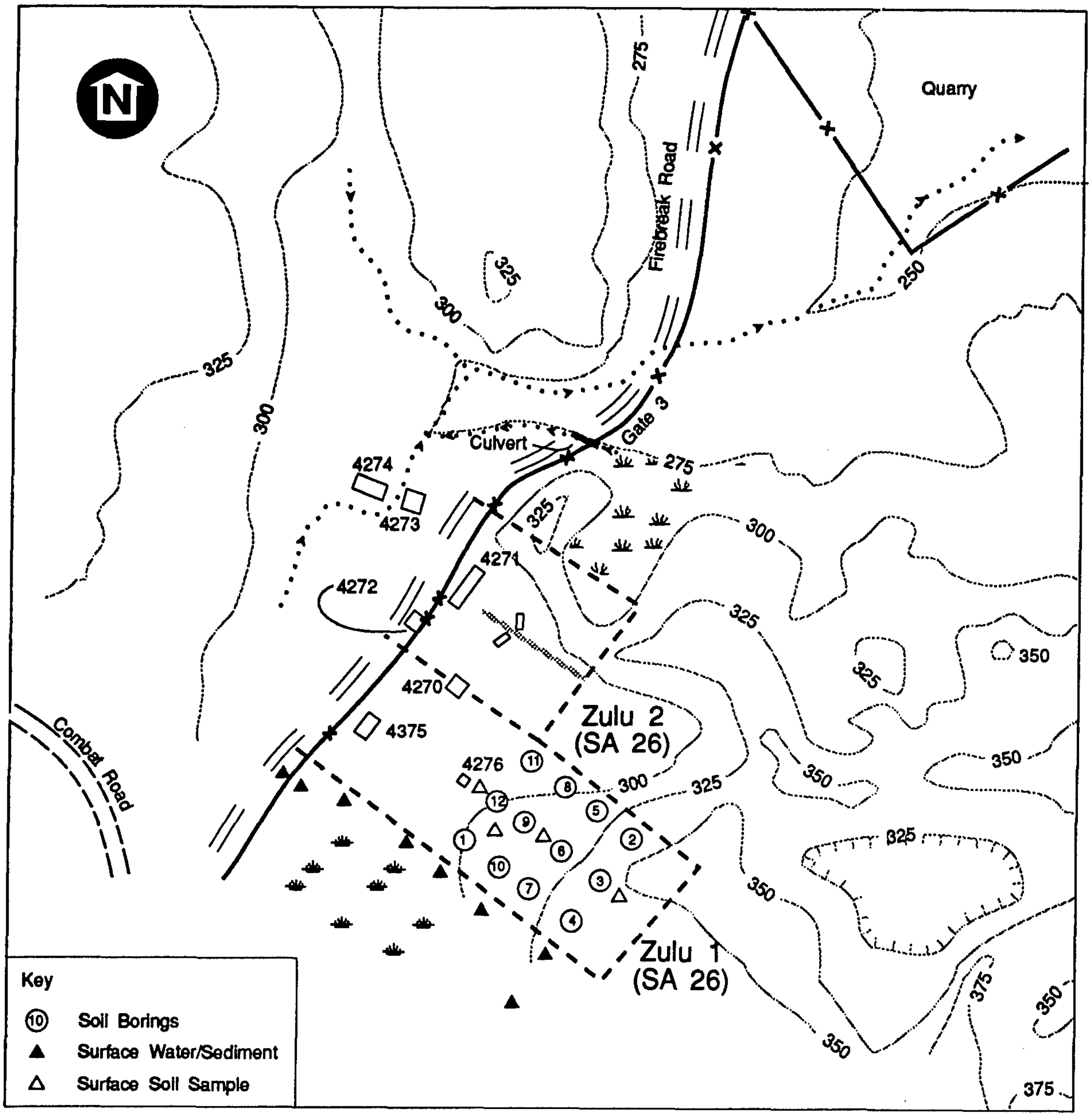
Table 2-4

SAMPLE SCHEME FOR SA 15 (LANDFILL 11)*

SITE TYPE	SITE ID	ANALYSIS
BORE	LF11-01-01	TCL, TAL, TPHC
BORE	LF11-01-02	TCL, TAL, TPHC
BORE	LF11-01-03	TCL, TAL, TPHC, TCLP Metals/Organics
BORE	LF11-01-04	TCL, TAL, TPHC
BORE	LF11-01-05	TCL, TAL, TPHC
BORE	LF11-01-06	TCL, TAL, TPHC
BORE	LF11-01-07	TCL, TAL, TPHC
BORE	LF11-01-08	TCL, TAL, TPHC
BORE	LF11-01-09	TCL, TAL, TPHC
BORE	LF11-01-10	TCL, TAL, TPHC
BORE	LF11-02-01	TCL, TAL, TPHC
BORE	LF11-02-02	TCL, TAL, TPHC
BORE	LF11-02-03	TCL, TAL, TPHC, TCLP Metals/Organics
BORE	LF11-02-04	TCL, TAL, TPHC
BORE	LF11-02-05	TCL, TAL, TPHC
BORE	LF11-02-06	TCL, TAL, TPHC
BORE	LF11-02-07	TCL, TAL, TPHC
BORE	LF11-02-08	TCL, TAL, TPHC
BORE	LF11-02-09	TCL, TAL, TPHC
BORE	LF11-02-10	TCL, TAL, TPHC
BORE	LF11-03-01	TCL, TAL, TPHC
BORE	LF11-03-02	TCL, TAL, TPHC
BORE	LF11-03-03	TCL, TAL, TPHC
BORE	LF11-03-04	TCL, TAL, TPHC
BORE	LF11-03-05	TCL, TAL, TPHC
BORE	LF11-03-06	TCL, TAL, TPHC
BORE	LF11-03-07	TCL, TAL, TPHC
BORE	LF11-03-08	TCL, TAL, TPHC
BORE	LF11-03-09	TCL, TAL, TPHC
BORE	LF11-03-10	TCL, TAL, TPHC
BORE	LF11-04-01	TCL, TAL, TPHC
BORE	LF11-04-02	TCL, TAL, TPHC
BORE	LF11-04-03	TCL, TAL, TPHC, TCLP Metals/Organics
BORE	LF11-04-04	TCL, TAL, TPHC
BORE	LF11-04-05	TCL, TAL, TPHC
BORE	LF11-04-06	TCL, TAL, TPHC
BORE	LF11-04-07	TCL, TAL, TPHC
BORE	LF11-04-08	TCL, TAL, TPHC
BORE	LF11-04-09	TCL, TAL, TPHC
BORE	LF11-04-10	TCL, TAL, TPHC

TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons
TCLP: Toxicity Characteristic Leaching Procedure

*Refer to Table 2-8 for QA/QC samples



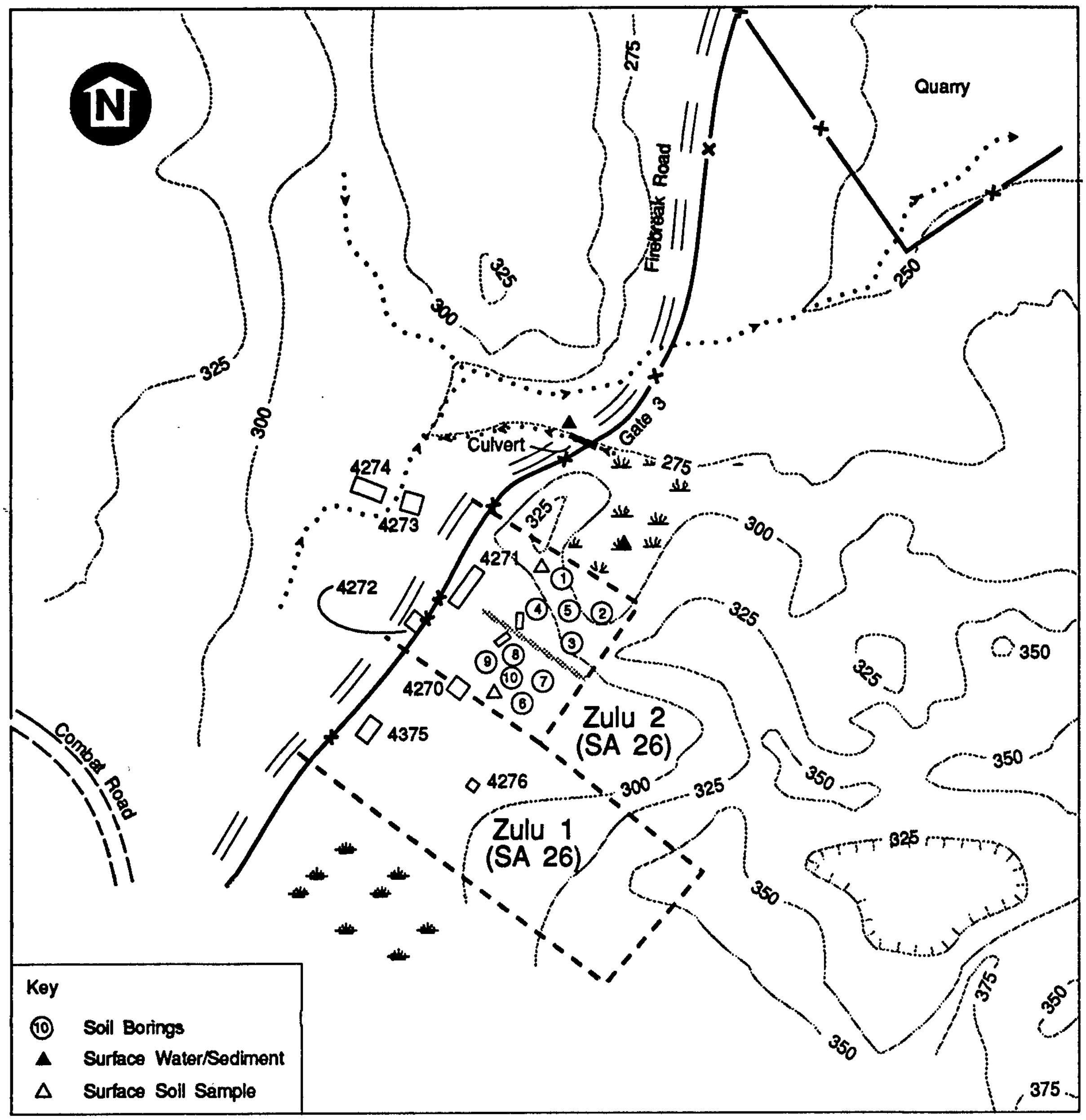
Source: Fort Devens, COE, NY, DWG, 18-02-26/16, 1988

Legend

—275—	Contour	—x—	Fence
▭	Building, Temporary	· · ▸ · ·	Surface Drainage and Directional Flow
═══	Road, Unimproved	— — —	Zulu Range
	Wetland		Sand Barrier

Scale In Feet
0 100 200 300 400 800

Figure 2-6A SAMPLING LOCATIONS AT STUDY AREA 26 (ZULU 1)



Source: Fort Devens, COE, NY, DWG, 18-02-26/16, 1988

Legend

Contour
Building, Temporary
Road, Unimproved
Wetland
Fence
Surface Drainage and Directional Flow
Zulu Range
Sand Barrier

Scale In Feet
0 100 200 300 400 800

Figure 2-6B SAMPLING LOCATIONS AT STUDY AREA 26 (ZULU 2)

00409M5.CDR

Table 2-5A

SAMPLE SCHEME FOR SA 26 (ZULU 1 RANGE)*

SITE TYPE	SITE ID	ANALYSIS
BORE	ZULU1-01-1	Explosives, TCL, TAL
BORE	ZULU1-01-2	Explosives, TCL, TAL
BORE	ZULU1-01-3	Explosives, TCL, TAL
BORE	ZULU1-02-1	Explosives, TCL, TAL
BORE	ZULU1-02-2	Explosives, TCL, TAL
BORE	ZULU1-02-3	Explosives, TCL, TAL
BORE	ZULU1-03-1	Explosives, TCL, TAL
BORE	ZULU1-03-2	Explosives, TCL, TAL
BORE	ZULU1-03-3	Explosives, TCL, TAL
BORE	ZULU1-04-1	Explosives, TCL, TAL
BORE	ZULU1-04-2	Explosives, TCL, TAL
BORE	ZULU1-04-3	Explosives, TCL, TAL
BORE	ZULU1-05-1	Explosives, TCL, TAL
BORE	ZULU1-05-2	Explosives, TCL, TAL
BORE	ZULU1-05-3	Explosives, TCL, TAL
BORE	ZULU1-06-1	Explosives, TCL, TAL
BORE	ZULU1-06-2	Explosives, TCL, TAL
BORE	ZULU1-06-3	Explosives, TCL, TAL
BORE	ZULU1-07-1	Explosives, TCL, TAL, TCLP metals and organics
BORE	ZULU1-07-2	Explosives, TCL, TAL
BORE	ZULU1-07-3	Explosives, TCL, TAL
BORE	ZULU1-08-1	Explosives, TCL, TAL
BORE	ZULU1-08-2	Explosives, TCL, TAL
BORE	ZULU1-08-3	Explosives, TCL, TAL
BORE	ZULU1-09-1	Explosives, TCL, TAL
BORE	ZULU1-09-2	Explosives, TCL, TAL
BORE	ZULU1-09-3	Explosives, TCL, TAL
BORE	ZULU1-10-1	Explosives, TCL, TAL
BORE	ZULU1-10-2	Explosives, TCL, TAL, TCLP metals and organics
BORE	ZULU1-10-3	Explosives, TCL, TAL
BORE	ZULU1-11-1	Explosives, TCL, TAL
BORE	ZULU1-11-2	Explosives, TCL, TAL
BORE	ZULU1-11-3	Explosives, TCL, TAL
BORE	ZULU1-12-1	Explosives, TCL, TAL
BORE	ZULU1-12-2	Explosives, TCL, TAL
BORE	ZULU1-12-3	Explosives, TCL, TAL
POND	SW-ZULU1-1	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-1	Explosives, TCL, TAL, TPHC, TOC, Grain Size
POND	SW-ZULU1-2	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-2	Explosives, TCL, TAL, TPHC, TOC, Grain Size
POND	SW-ZULU1-3	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-3	Explosives, TCL, TAL, TPHC, TOC, Grain Size
POND	SW-ZULU1-4	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-4	Explosives, TCL, TAL, TPHC, TOC, Grain Size
POND	SW-ZULU1-5	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-5	Explosives, TCL, TAL, TPHC, TOC, Grain Size
POND	SW-ZULU1-6	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-6	Explosives, TCL, TAL, TPHC, TOC, Grain Size
POND	SW-ZULU1-7	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-7	Explosives, TCL, TAL, TPHC, TOC, Grain Size
POND	SW-ZULU1-8	Explosives, TCL, TAL, TPHC, Hardness
POND	SE-ZULU1-8	Explosives, TCL, TAL, TPHC, TOC, Grain Size

TOC: Total Organic Carbon
TCLP: Toxicity Characteristics Leaching Procedure
TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons

*Refer to Table 2-8 for QA/QC samples

Table 2-5B

SAMPLE SCHEME FOR SA 26 (ZULU 2 RANGE)*

SITE TYPE	SITE ID	ANALYSIS
BORE	ZULU2-01-1	Explosives, TAL, TCL
BORE	ZULU2-01-2	Explosives, TAL, TCL
BORE	ZULU2-01-3	Explosives, TAL, TCL
BORE	ZULU2-02-1	Explosives, TAL, TCL
BORE	ZULU2-02-2	Explosives, TAL, TCL, TCLP metals and organics
BORE	ZULU2-02-3	Explosives, TAL, TCL
BORE	ZULU2-03-1	Explosives, TAL, TCL
BORE	ZULU2-03-2	Explosives, TAL, TCL
BORE	ZULU2-03-3	Explosives, TAL, TCL
BORE	ZULU2-04-1	Explosives, TAL, TCL
BORE	ZULU2-04-2	Explosives, TAL, TCL
BORE	ZULU2-04-3	Explosives, TAL, TCL
BORE	ZULU2-05-1	Explosives, TAL, TCL
BORE	ZULU2-05-2	Explosives, TAL, TCL
BORE	ZULU2-05-3	Explosives, TAL, TCL
BORE	ZULU2-06-1	Explosives, TAL, TCL
BORE	ZULU2-06-2	Explosives, TAL, TCL
BORE	ZULU2-06-3	Explosives, TAL, TCL
BORE	ZULU2-07-1	Explosives, TAL, TCL
BORE	ZULU2-07-2	Explosives, TAL, TCL
BORE	ZULU2-07-3	Explosives, TAL, TCL
BORE	ZULU2-08-1	Explosives, TAL, TCL
BORE	ZULU2-08-2	Explosives, TAL, TCL
BORE	ZULU2-08-3	Explosives, TAL, TCL, TCLP metals and organics
BORE	ZULU2-09-1	Explosives, TAL, TCL
BORE	ZULU2-09-2	Explosives, TAL, TCL
BORE	ZULU2-09-3	Explosives, TAL, TCL
BORE	ZULU2-10-1	Explosives, TAL, TCL
BORE	ZULU2-10-2	Explosives, TAL, TCL
BORE	ZULU2-10-3	Explosives, TAL, TCL, TCLP metals and organics
POND	SW-ZULU2-1	Explosives, TAL, TCL, TPHC, Hardness
POND	SE-ZULU2-1	Explosives, TAL, TCL, TPHC, TOC, Grain Size
POND	SW-ZULU2-2	Explosives, TAL, TCL, TPHC, Hardness
POND	SE-ZULU2-2	Explosives, TAL, TCL, TPHC, TOC, Grain Size

TOC: Total Organic Carbon
TCLP: Toxicity Characteristics Leaching Procedure
TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons

*Refer to Table 2-8 for QA/QC samples

Table 2-6

SAMPLE SCHEME FOR SA 48 (BUILDING 202)*

SITE TYPE	SITE ID	ANALYSIS
BORE	B202-01-01	TPHC
BORE	B202-01-02	TPHC
BORE	B202-01-03	TPHC
BORE	B202-01-04	TPHC
BORE	B202-01-05	TPHC
BORE	B202-01-06	TPHC
BORE	B202-01-07	TPHC
WELL	Well B202-02	TPHC, TCL, TAL, cations/anions
WELL	Well B202-03	TPHC, TCL, TAL, cations/anions
WELL	Well B202-04	TPHC, TCL, TAL, cations/anions

TPHC: Total Petroleum Hydrocarbons
TCL: Target Compound List
TAL: Target Analyte List

*Refer to Table 2-8 for QA/QC samples

Of the 10 water and 10 sediment samples to be taken from the two drainage pathways around this site, 8 of the samples will be taken from the wetland south of Zulu 1; the remaining 2 samples are to be taken from the wetland north of Zulu 2. The 20 samples will be analyzed for explosives, TCL organics, TAL metals, and TPHC. In addition, the 10 sediment samples will be analyzed for Total Organic Carbon (TOC) and grain size, while the 10 surface water samples will also be analyzed for hardness. For the water samples, dissolved oxygen, pH, and specific conductance will be measured in the field. Figures 2-6A and 2-6B show proposed sampling locations, and Tables 2-5A and 2-5B detail the sampling scheme for this site.

2.3.3 Geotechnical Samples

USATHAMA Geotechnical Requirements (Appendix A) state that boring logs will be made and lithologic samples will be collected from any borehole greater than 5 feet in depth. Therefore, lithologic samples will be collected at SAs 15, 25, 26, and 48. Furthermore, if a borehole is to be completed as a well, a lithologic sample from the screened interval should be analyzed for physical parameters. Physical soil testing, consisting of sieve grain size distribution, Atterberg Limits, and the assignment of unified soil classification system (USCS) symbols will be conducted on 10 to 20 percent of the samples collected for lithologic descriptions. Geotechnical samples, other than those sent out for analysis, are turned over to the Fort Devens Directorate of Engineering and Housing (DEH).

At SA 15, for borings totaling approximately 100 linear feet are scheduled and will produce 20 geotechnical samples. At SA 25, four groundwater monitoring wells are scheduled to be installed with an estimate of 120 feet of drilling. At SA 25, roughly 24 geotechnical samples will be taken but since 4 wells are to be installed, 4 samples will be sent for physical analysis. At SA 26, Zulu 2, E & E will use hand augers to drill 10 10-foot-deep holes, which will produce 20 geotechnical samples. At Zulu 1, 12 10-foot-deep trenches will produce 24 geotechnical samples. At SA 48, 3 wells and 1 borehole will be drilled for an estimated total of 125 linear feet and 25 geotechnical samples. Since three wells will be completed, three samples will be sent for physical analysis.

2.3.4 Groundwater Samples

Two rounds of groundwater samples will be collected from each of the seven new monitoring wells installed during the SIs. At SA 25, the four wells will be sampled, in appropriate containers and volumes, for explosives and TCL organics, TAL metals, TPHC, and common cations and anions. Well locations are found in Figure 2-1 and the sampling scheme in Table 2-7. At SA 48, the three wells will be sampled, in appropriate containers and volumes, for TCL organics, TAL metals, and TPHC and common cations and anions. Well locations are found in Figure 2-2 and the sampling scheme in Table 2-6.

Table 2-7

SAMPLE SCHEME FOR SA 25 (EOD RANGE)*

SITE TYPE	SITE ID	ANALYSIS
WELL	EOD-1	Explosives, TCL, TAL, TPHC, cations/anions
WELL	EOD-2	Explosives, TCL, TAL, TPHC, cations/anions
WELL	EOD-3	Explosives, TCL, TAL, TPHC, cations/anions
WELL	EOD-4	Explosives, TCL, TAL, TPHC, cations/anions

TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons

*Refer to Table 2-8 for QA/QC samples

2.3.5 Field QC Samples

Various types of field QC samples are used to check the effectiveness of field handling methods. They are analyzed in the laboratory as samples, and their purpose is to assess the sampling and transport procedures as possible sources of sample contamination and to determine overall sampling and analytical precision.

Field QC samples and the frequency of collection are described below:

Trip Blanks are field blanks that are not exposed to field conditions. Their analytical results provide the overall level of contamination from everything except ambient field conditions. Trip blanks are prepared at the laboratory prior to the sampling event and shipped with the sample bottles. Trip blanks are prepared by adding organic-free water to a 40-ml volatile organic analysis (VOA) vial containing 2 to 3 drops of concentrated hydrochloric acid. One trip blank will be used with every cooler of samples, or one trip blank per 10 volatile organic samples (regardless of matrix) will be used, whichever is greater. Each trip blank will be transported to the sampling location, handled like a sample, and returned to the laboratory for analysis without being opened in the field.

Field Equipment/Rinsate Blanks are field blank samples designed to demonstrate that sampling equipment has been properly prepared and cleaned before field use and that cleaning procedures between samples are sufficient to minimize cross-contamination. Rinsate blanks are prepared by passing analyte-free water over sampling equipment and analyzing the samples for all applicable parameters. If a sampling team is familiar with a particular site, its members may be able to predict which areas or samples are likely to have the highest concentration of contaminants. Unless other constraints apply, these samples should be taken last to avoid excessive contamination of sampling equipment.

Rinsate blanks will only be collected at a frequency of 1 per 20 samples per decontamination event. Rinsate blanks will not be collected with sampling activities using dedicated equipment.

Field Duplicates consist of a set of two samples collected independently at a sampling location during a single sampling event. Field duplicates can be sent to the laboratory so that they are indistinguishable from other analytical samples and personnel performing the analyses are not able to determine which samples are field duplicates. Field duplicates are designed to assess the consistency of the overall sampling and analytical system. Duplicates will be collected for every 20 samples of each type of matrix.

For a discussion of laboratory QC samples, please refer to sections 10.2 and 10.3 of the QAPjP. Table 2-8 presents a summary of the number and type of samples, the number of field blanks and duplicates, and the analytical requirements.

2.4 HYDRAULIC CONDUCTIVITY

Following installation and prior to sampling, the seven new SI wells will be subjected to hydraulic conductivity testing (slug tests), which will allow for a preliminary characterization of in-situ aquifer properties such as hydraulic conductivity and/or transmissivity. Water level response data will be collected using a data logger (e.g., Hermit 1000 or Hermit 2000) and pressure transducer system (e.g., 10 or 20 psi transducers). Slug test response data will be analyzed using the method of Bouwer and Rice (1976) or Cooper et al. (1967). The method selected will be determined by the hydrogeologic condition of the aquifer zone tested and assumptions inherent for each method.

2.5 ELEVATION AND LOCATION SURVEYING

Each of the seven well and five soil boring locations drilled during the SI will be topographically referenced by a licensed surveyor ±1.0 feet of its geodetic coordinates based on State Planar Coordinates. Furthermore, the elevation of each well, at ground surface, at the top of the riser, and at the top of the protective well casing will be surveyed to ±.05 feet referenced to the National Geodetic Vertical Datum of 1929. The survey data will be recorded in accordance with USATHAMA geotechnical requirements (1987).

Table 2-8

SUMMARY OF ANALYTICAL REQUIREMENTS

Site Name	Analysis	Number of Samples	QA/QC Samples Dup	Trip(*)	Rin	MS/ MSD(**)	MS/Lab	Total Number Samples
Landfill 11	TCL	40	2	0	2	1	0	45
SA 15	TAL	40	2	0	2	0	1	45
	TPHC	40	2	0	2	0	0	44
	TCLP Metals & Organics	3	0	0	0	0	0	3
Bunker 187	Explosives	5	1	0	0	0	0	6
SA 24	TCLP Metals & Organics	1	0	0	0	0	0	1
EOD Range	TCL	8	1	2	2	1	0	14
SA 25	TAL	8	1	0	2	0	1	12
	TPHC	8	1	1	2	0	0	12
	Explosives	8	1	0	2	1	0	12
	anions, cations	8	1	0	2	0	0	11
Zulu Range	TCL (water)	10	0	2	0	1	0	13
SA 26	TCL (sediment)	10	1	0	0	0	0	11
	TCL (soil)	66	4	0	4	1	0	75
	TAL (water)	10	0	0	0	0	1	11
	TAL (sediment)	10	1	0	0	0	0	11
	TAL (soil)	66	4	0	4	0	1	75
	Explosives (water)	10	0	0	0	1	0	11
	Explosives (sediment)	10	1	0	0	0	0	11
	Explosives (soil)	66	4	0	4	1	0	75
	Explosives (soils - qualitative)	6	0	0	0	0	0	6
	TCLP Metals & Organics	5	1	0	0	0	0	6
	TPHC (water/sediment)	20	1	0	0	0	0	21
	TOC (sediment)	10	1	0	0	0	0	11
	Hardness	10	1	0	0	0	0	11
DRMO Yard	TCL	11	1	0	0	1	0	13
SA 32	TAL	11	1	0	0	0	1	13
	TCLP Metals & Organics	2	0	0	0	0	0	2
	TPHC	11	1	0	0	0	0	12
Bldg. 202	TCL (water)	6	1	2	1	0	0	10
SA 48	TAL (water)	6	1	0	1	0	0	8
	TPHC (water)	6	1	0	1	0	0	8
	anions, cations (water)	6	1	0	1	0	0	8
	TPHC (soil)	7	1	0	0	0	0	8

TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons
TCLP: Toxicity Characteristic Leaching Procedure
TOC: Total Organic Carbon
Anions/Cations: bicarbonate, chloride, sulfate, nitrate, dissolved oxygen, and total nitrogen (Cations: calcium, potassium, and magnesium are included in TAL)

*Trip blank will be analyzed only for VOAs.
**MS/MSD samples are for pesticide/PCB and explosives analysis only. MS/MSD samples will be collected for methods which do not use USATHAMA surrogates.

3. FIELD PROCEDURES

The field investigation for the SI sites will include geophysical and soil-gas surveys, monitoring well installation, groundwater sampling, surface water sampling, sediment sampling, soil sampling, decontamination, and waste disposal. The procedures to be used for field surveys and the collection of samples are described in the following sections.

3.1 GEOPHYSICAL SURVEYS

3.1.1 Ground Conductivity Survey of SA 15 (Landfill 11)

To identify the boundaries of suspected trenches at SA 15, an electromagnetic survey, using an EM-31 Terrain Ground Conductivity Meter manufactured by Geonics Limited of Mississauga, Ontairo, will be conducted at this site. In addition to the identified boundaries, this geophysical survey can provide the following information:

- areas of suspected buried waste and possible, near surface soil contamination;
- natural background geophysical characteristics outside of past landfill activities area; and
- locations of buried utilities, drums, and construction debris.

The EM-31 measures the average conductance, in millimhos per meter, of the material beneath it in a hemispherical volume approximately 18 feet in diameter. The magnetometer measures the total earth's field and indicates where there is a sharp gradient in the magnetic field. Each instrument can detect ferromagnetic materials (iron and steel) which distort the magnetic field and create changes in magnetic gradients as well as being highly conductive. The EM-31 can also detect contrasts in conductivity due to geologic conditions, (such as changes in clay or peat content compared to sand) and can detect non-ferrous metals such as aluminum.

This instrument can define the extent of the fill if it has sufficient contrast in physical properties to distinguish it from natural materials. A grid with 100-foot intervals will be laid out over the suspected extent of the fill and overlapping onto areas where fill might be present (see Figure 3-1). The grid will be marked by wooden stakes prior to mobilization of geophysical survey personnel and equipment. Each grid line will be cleared of vegetation sufficiently to permit access and the magnetic field/magnetic gradient and average conductivity noted at each grid node and at intervals along each grid line. The data will be interpreted and the extent of the fill estimated. The EM-31 will be used in both the horizontal and vertical dipole positions to assist in estimating the depths to detectable targets, if any, in anomalous areas.

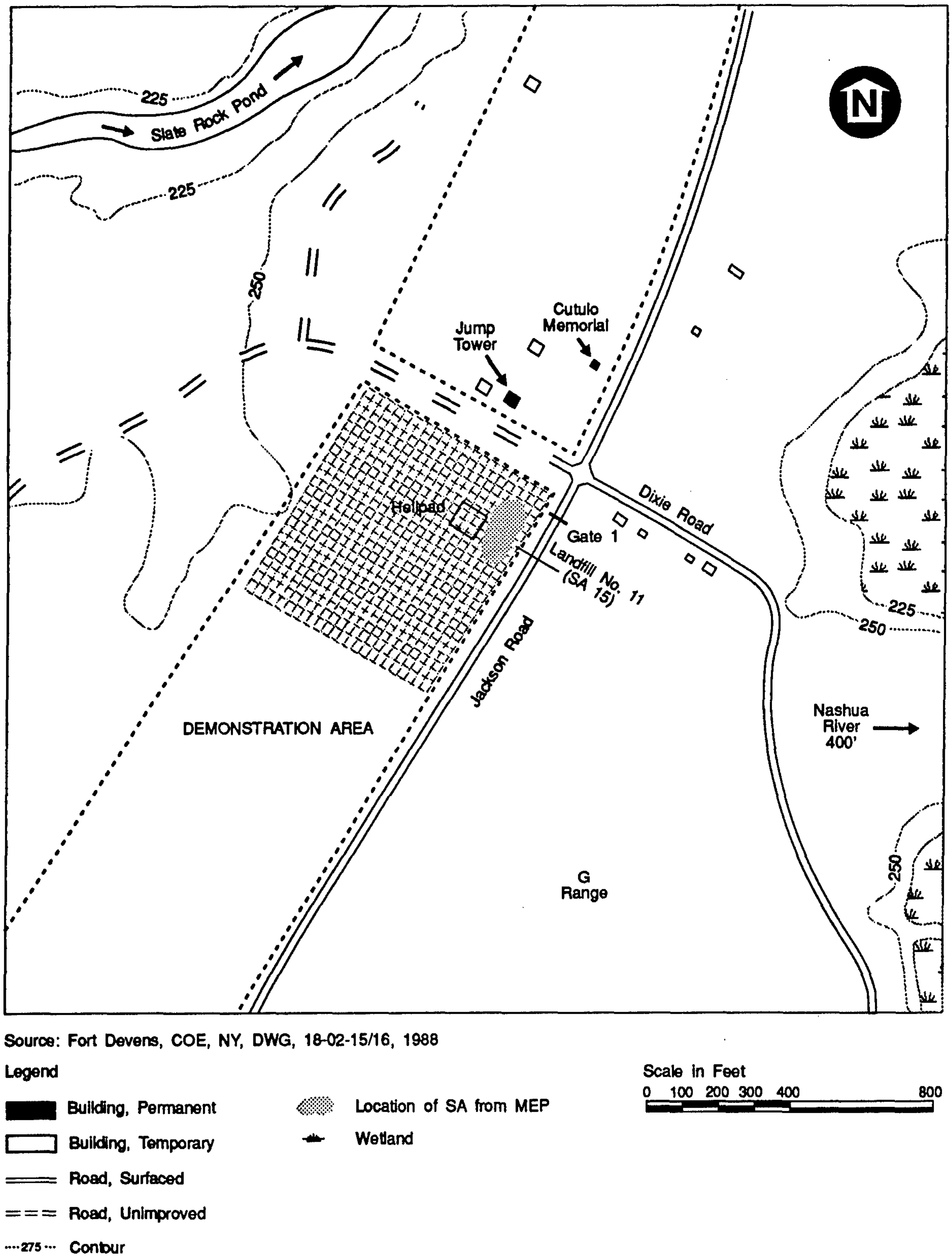


Figure 3-1 STUDY AREA 15 (LANDFILL NUMBER 11) GEOPHYSICAL SURVEY GRID

A magnetic survey entails conducting a series of measurements of the magnetic field. Measurements are taken at specific intervals along successive parallel traverse lines which together form a grid. Spatial changes in the magnetic field are identified by two methods: examination of two-dimensional graphs of the magnetic field generated from data obtained along traverse lines, and examination of a contour map of the magnetic field data produced for the survey grid.

The instrument is battery operated and has a digital LED (light emitting diode) display and an electronic memory capable of storing 1,000 readings. The memory will be transferred electronically in a computer for data processing.

Measurements of the magnetic field will be conducted at 10-foot intervals on the traverse lines. As a means of decreasing interference caused by surficial magnetic objects, the magnetometer will be mounted on a 6-foot staff so that, in effect, measurements will be made 6 feet above the ground surface at the site. In addition, the person holding the polarizing coil will be free of any ferromagnetic material and separated from the instrument controls and batteries by the distance of the coil cable. This will eliminate possible interferences from small ferromagnetic objects in proximity to the polarizing coil.

Collected data will be processed as follows:

- Data taken in the field will be transferred electronically from the magnetometer memory into a microcomputer system. As a result, the possibility of transcription errors will be eliminated.

- Data from traverse lines will be plotted by computer, as magnetic field profile lines, with the magnetic field as the y-axis and distance in feet as the x-axis.

- Anomalies that represent magnetic objects will be identified on profiles and contour maps.

- Anomalies caused by surficial objects (if applicable) such as fences, railroad tracks, power lines, steel buildings, and iron or steel material, will be identified by reference to the site topographic map and field notes taken during the survey.

- The locations of buried magnetic objects (if present) and estimated depths of burial will be identified within magnetically anomalous zones.

The data collected in field will be used to generate two-dimensional terrain conductivity profiles, and a conductivity contour map for the surveyed area. The boundaries of the landfill will be marked open profiles and mapped (if appropriate); areas of abnormally elevated or lowered conductivity, called geophysical anomalies, will be identified on the contour map.

3.1.2 Geophysical Survey and Monitoring for Unexploded Ordnance at SAs 25 and 16.

Before E & E begins field work, UXB personnel will survey all locations at the EOD Range adn Zulu ranges where E & E personnel will be working. Because the ranges are active facilities, UXB personnel will provide site safety briefings and precede E & E personnel, or any other personal (USATHAMA, Fort Devens, or EPA) who may enter these sites.

General requirements for unexploded ordnance (UXO) contractors include adherence to the U.S. Army Services 60 Manual for handling ordnance items, (the latest version will be provided by the EOD unit at Fort Devens), and following the current USATHAMA Safety Office Guidance.

Specifically the UXO contractor will:

- o Provide detailed standard operating procedures (SOPs) for all UXO procedures.
- o Provide the capability and equipment to communicate with off-site emergency response personnel (cellular and/or radio telephones will probably be used).
- o Conduct UXO operations only during daylight hours.
- o Cease conducting UXO operations during thunder/lighting storms or other severe weather conditions or if these weather conditions are imminent.
- o Conduct UXO operations with a minimum of two UXO subcontractor personnel, equally qualified and knowledgeable of UXO.
- o Coordinate and establish written agreements/arrangements, prior to initiation of field work, with the geographically responsible military EOD unit and/or Fort Devens personnel, for the rendering safe and disposal of UXO by detonation or burning.
- o Report UXO that cannot be safely removed to the geographically responsible military EOD unit and/or Fort Devens personnel for rendering safe and disposal.
- o Remove ordnance items determined to be expended and stage as non-hazardous waste.
- o Collect all UXO and/or energetic materials that are safe to move and stage at a properly sited holding area on site, pending disposal.

- o Coordinate and establish arrangements/agreements for packaging and transportation of UXO and/or explosive material to an approved government storage or open burning/open detonation (OB/OD) location if OB/OD operations cannot be conducted on site.

- o Have stop work authority on-site at SAs with potential UXO and/or shock-sensitive soils.

- o Have direct access to the USATHAMA Contracting Officer's Technical Representative (COTR). The USATHAMA COTR will be notified of areas of disagreement between the Contractor and the UXO subcontractor.

UXO will support performance of specific SI field activities including: SA access, geophysical survey, and surface and subsurface soil sampling. The following procedures/requirements shall be followed for site access to areas where UXO is potentially present.

To ensure safe and clear access through areas where the potential for UXO exists, a clearance team of two UXB personnel will conduct a visual sweep of the proposed route, and clear and mark a path 10 feet wide. They will maintain a line of sight with each other at all times, and will maintain communication with other field crew members (e.g., E & E). If UXO is encountered, it will be marked, identified, and a route laid out around the hazard by the UXB team. If rough terrain or an abundance of hazardous items prohibit the identification of a clean and clear route around the hazard, UXO that can be moved remotely will be placed outside of the area to be cleared. The UXB team will plan to provide an alternate clear route out of the UXO area should the need for one arise.

UXB personnel propose to use both the Foerster Ferex Ordnance Locator in conjunction with a White's Eagle II Metal Detector. Both instruments and their capabilities are described below.

The Foerster Ferex Ordnance Locator is the most recent military approved locator and is in use by the U.S. Military EOD forces, designated the MK 26 Ordnance Locator, for subsurface ordnance items. The locator is a hand-held unit and uses two flux-gate magnetometers, aligned and mounted a fixed distance apart to detect changes in the earth's ambient magnetic field caused by ferrous metals.

Both an audio and metered signal are provided to the operator. The metered signal indicates whether the disturbance is geodetic or metal-related. The detection capability of the Foerster Ferex is dependent on the size of the item versus its depth.

The Foerster Ferex is capable of ordnance location to the following depths:

ITEM	DEPTH
Small Arms Round	1 foot
Hand Grenade	2 feet
Antipersonnel Mine	3 feet
Antitank Mine	4.5 feet
Medium Projectile	10 feet
Small Bomb	15 feet
Large Bomb	19 feet

Although the Foerster Ferex Ordnance Locator will detect disturbances caused by changes in soil conditions, its ability to detect metallic items is not affected by local soil conditions.

The White's Eagle II Metal Detector is a hand-carried, microprocessor controlled metal detector with a Liquid Crystal Display and a keypad user interface. This metal detector operates on the induction principle whereby a transmitter coil induces eddy currents within buried metal and these induced eddy currents are received by a receiver unit. The advantage of this detector is that it can detect both ferrous and non-ferrous metals.

During boring operations using the drill rig, the UXB team will clear the surface and dig the first 2 feet using a shovel, hand auger, or post hole digger. The team will perform a down hole search of the point using the Foerster Ferex Ordnance Locator assembled in the borehole mode. This procedure will ensure that the well/bore site is clear and void of UXO for the first 2 feet and the next 2 subsurface feet. If no significant metallic contacts are encountered, the drilling crew will be allowed to set up and begin drilling in increments of 2 or 5 feet. If a significant metallic contact is discovered, the drilling site will be abandoned, moved at least 10 feet, and the above procedure repeated. Each 2 or 5 feet of mechanized drilling will require the drill rig to be moved off the hole and subsurface scanning to be conducted down to a preliminary depth of 25 feet. After this depth has been cleared, drilling can proceed without further interruption if this depth is exceeded. This is because no ordnance is expected below 25 feet. The maximum depth for subsurface scanning will be decided by UXB and adjusted as necessary based on field observations.

3.2 SOIL-GAS SURVEY

A qualitative soil-gas field survey using an OVA will be performed to determine the presence or absence of VOCs in the soil associated with past oil disposal activities at SA 15. The survey also will be used to better define the anomalies which are potential trench locations found during the geophysical survey. This soil-gas survey will only be performed after reviewing aerial photos and geophysics has targeted any potential disposal area(s).

A grid will be set at 50-foot spacings over the suspected area of the trench(es). This activity is generalized in Figure 3-1.

At each intersection, a 2-foot-long disposable wooden probe will be hammered into the soil to a depth of approximately 1 foot. If the wooden probe intersects the oil residue, it will be considered a positive identification of the waste material. The tip of the OVA probe will be fitted to a tube connected to a large Teflon funnel, which will be inverted over the survey hole. The deflection of the needle on the OVA in response to vapors emanating from the survey point will be recorded in the logbook and a two-dimensional contour map will be generated. Since only a positive or negative response is required for organic vapors, quantitative analysis provides no added benefit. If false negative readings are suspected due to the sensitivity of the OVA and the age of the waste oil, a portable gas chromatograph will be used to resurvey the SA. Field considerations will include performing the survey under warm and dry weather conditions.

3.3 MONITORING WELL INSTALLATION

The groundwater investigation program for the SI sites includes the installation of four shallow (25 to 40 foot) groundwater monitoring wells at SA 25 and three shallow (35 to 40 foot) groundwater monitoring wells at SA 48. The well locations are shown in Figures 2-1 and 2-2. All wells will be constructed according to USATHAMA geotechnical requirements (see Appendix A).

As required, the water, sand, and bentonite used for well installation will be approved by USATHAMA prior to the drilling operation. Representative samples will be provided to the Fort Devens DEH. The USATHAMA approved water source for the project is Fort Devens production well D-1 located on the South Post.

Drilling will be accomplished through hollow-stem augers. Geotechnical soil samples will be collected using split spoons at 5-foot intervals. The collected soil samples will be used for lithologic descriptions only and representative samples will be saved and left with the Fort Devens Directorate of Engineering and Housing (DEH). The only lubricants to be used on the drilling augers will be Teflon tape.

All monitoring wells will be constructed within the unconsolidated glacial deposits above bedrock. Monitoring wells will be constructed of 4-inch inside diameter (ID), threaded, flush joint, polyvinylchloride (PVC) riser, and a 10-foot section of a 4-inch ID, flush joint, PVC with a 0.010 inch, machine slotted, screen. A review of previous boring-logs indicates use of 0.010 inch screen is appropriate. In wells to bedrock that are less than 20 feet deep, a 5-foot screen may be used if the saturated thickness is also less than 5 feet.

The wells will be drilled to a depth of 10 feet below the water table, and the top of the 10-foot screen will extend 1 or 2 feet above the water table. This will allow for the detection of floating products, if any, to collected on top of the water table. Figure 3-2 shows details of general monitoring well construction proposed for the the SI sites.

All construction material will be National Sanitation Foundation/ American Society for Testing and Materials (NSF/ASTM) approved. All well installations will include a sand filter pack around the screen, extending 5 feet above it. A 5-foot bentonite seal will be placed above the sand and a mix of bentonite/Portland cement grout will extend to the surface. Grouting will be accomplished through a tremie pipe lowered to the bottom of the zone to be grouted. The grout will be composed by weight of 20 parts Portland cement, Type II or Type V, and up to 1 part bentonite. A maximum of 8 gallons of water will be used per 94-pound bag of cement. The tremie pipe shall be of rigid PVC, drill rods, or metal pipe. Hoses and flexible PVC are not acceptable for use as a tremie.

A steel protective casing with locking cap (stick-up) will be installed around the PVC casing. Four steel pickets will be erected radially around the well. The protective casing will be brush painted orange and the well designation number will be painted in white.

Investigation-derived material showing evidence of contamination, either visually or by readings greater than 10 ppm on the OVA or HNu, will be drummed in 55-gallon (17E for liquids or 17H for solids) drums and stored in a secured area until analytical results are available and a proper disposal is recommended.

3.4 WELL DEVELOPMENT

The newly installed monitoring wells will be developed no sooner than 48 hours or no later than 1 week after installation. All wells will be developed for a minimum of 1 hour to improve efficiency, remove any foreign material introduced during drilling, and to reduce turbidity in the groundwater sample. Well development may be accomplished by use of a Teflon bailer or submersible pump at these sites. A fully developed well will meet USATHAMA specifications when the following criteria are meet:

- o The well water is clear to the unaided eye.
- o The sediment thickness remaining in the well is less than one percent of the screen length.
- o The total volume of water removed from the well equals five times the standing water volume in the well (including the well screen and casing plus saturated annulus, assuming 30 percent porosity within the sand pack) plus five times the volume of drilling fluid lost. (Note: Should the recharge to the well be

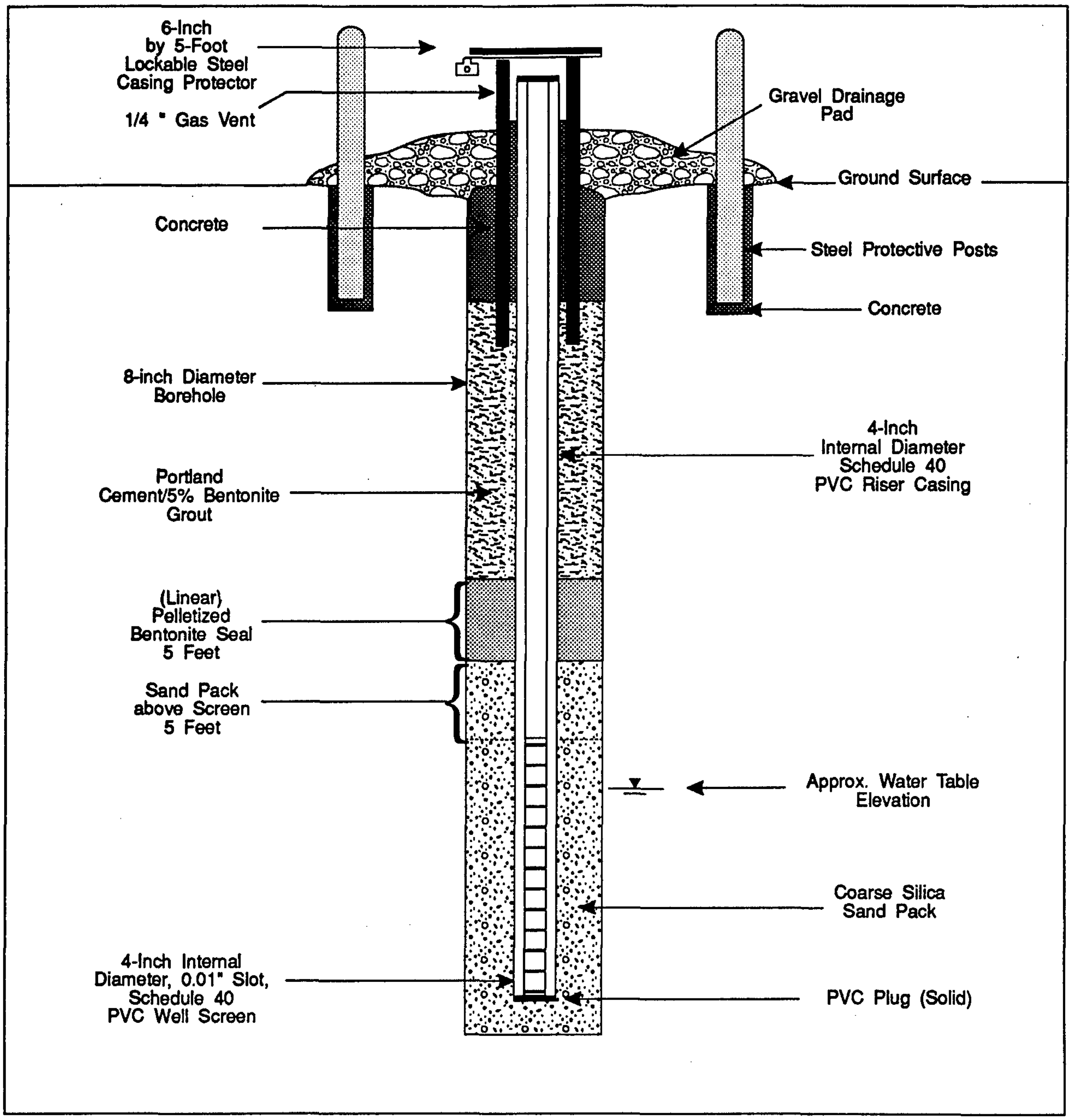


Figure 3-2 MONITORING WELL CONSTRUCTION

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so slow that the required volume cannot be removed in 48 consecutive hours, the water remains discolored, or excess sediment remains after the five-volume removal, the COTR should be contacted for guidance.)

3.5 GROUNDWATER SAMPLING

Sampling of the seven new wells at the SI sites will consist of the following activities:

- o measurement of depth to water level and total depth of the well (to calculate well volume);
- o purging of static water; and
- o sample collection.

These groundwater sampling activities follow USATHAMA's Quality Assurance Program (January 1990) and are described in the following sections.

3.5.1 Measurement of Water Level and Well Volume

Prior to sampling, the static water level and total depth of the well will be measured with an audible electronic water level meter. Care will be taken to decontaminate equipment between each use to avoid cross- contamination of wells. The number of liner feet of static water (difference between static water level and total depth of well) will also be calculated. The static volume will be calculated using the following formula:

$$V = Tr^2(0.163)$$

where:
V = static volume of well in gallons;
T = depth of water in the well, measured in feet;
r = inside radius of well casing in inches; and
0.163 = a constant conversion factor which compensates for $\pi r^2 h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and π (Pi).

In addition, to the water level measurements made at the time of well development, three full rounds of water level measurements will be conducted at both SI sites. The first, directly after the installation of all new wells, and then again at 3-month intervals.

3.5.2 Purging Static Water

Before a groundwater sample is obtained, the static water must be purged to ensure that a representative groundwater sample is taken. A minimum of five times the static water volume (including saturated annulus) will be purged from the well prior to collection of the samples. Purging will be performed using dedicated Teflon bailers or submersible pumps. The water removed from the well during the purging process will initially be containerized and observed visually and with monitoring instruments. If visual contamination is observed or if the headspace analysis of the purge water is greater than 10 parts per million (ppm) over background, the drums will be retained for RCRA classification and disposal per Fort Devens Hazardous Materials Plan (Reference Memorandum Tim Prior dated June 6, 1991). If the OVA readings are less than 10 ppm above background, the purge water will be disposed of at an on-site location.

3.5.3 Sample Collection

Sampling personnel will take precautions against cross-contamination by dedicating a Teflon bailer and rope to each well. Collection of groundwater samples from the monitoring well will be conducted in the following manner:

- Care will be taken that the appropriate number of pre-cleaned sample bottles, including preservatives, are transported to the field for sample collection. See Section 4 for details on the sampling containers, volumes, and preservatives necessary for the groundwater samples.

- Labels will be placed on pre-cleaned sample bottles prior to collection, if possible. Sample labels will be filled out with waterproof ink and will include sample name, sample identification, the specimen location, date time, preservatives added, and analytical purpose.

- The pre-cleaned glass sampling bottles will be triple rinsed with the sample water in order to fill up any unused ionic bonds on the glass surface. Water samples are to contain only liquids (no sludges, etc.).

- The sample will be collected in such a manner as to prevent agitation of the water, which promotes the loss of volatile organics and increases the dissolved oxygen content.

- Samples to be analyzed for volatile organics will have no headspace (or bubbles) in the sample jar, and will be handled as little as possible. A few drops of hydrochloric acid will be added to VOA samples to extend the holding times to 14 days. The order of collection is, typically, VOA, TPHC, extractables, metals, explosives, and anions/cations.

- Samples for other analyses will be collected in a pre-cleaned wide-mouthed bottle and transferred into triple rinsed 1/2-gallon glass bottles and other appropriate bottles required for chemical analyses within the scope of the project. The wide-mouthed bottle will be refilled as many times as necessary to fill all required bottles. Preservatives will not be added prior to rinsing.

- The temperature, pH, and specific conductance of the water will be measured in the field.

- Any observable physical characteristics of the water (e.g., color, odor, turbidity) will be recorded as it is being sampled in the field log book.

- Sample bottles will be wiped dry after being capped and placed in plastic bags to be shipped for analyses.

- Weather conditions at the time of sampling (e.g., air temperature, wind, and sky conditions, and precipitation will be recorded in the field log book.

3.6 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will be taken at locations described in Section 2.3.2. At each sampling location, one water and one sediment sample will be collected. The following sections describe the procedures for collecting surface water and sediment samples.

3.6.1 Surface Water Sampling

Surface water from wetlands and low gradient drainage areas adjacent to SA 26 will be collected in accordance with the following procedures:

- Care will be taken that the appropriate number of pre-cleaned sample bottles, including preservatives, are transported to the field for sample collection. See Section 4 and Tables 4-1 and 4-2 for the types of sample containers, volumes, and preservatives necessary for collecting the samples.

- Labels will be placed on pre-cleaned sample bottles prior to collection, if possible. Sample labels will be filled out with waterproof ink and will include sampler name, sample identification, sample location, date, preservatives added, and analytical purpose. The actual time of collection will be added after the sample is collected.

- A pre-cleaned wide-mouthed glass bottle to be used for sample collection will be dipped into the creek or pond and rinsed three times. The bottle then will be dipped to collect the sample and transfer water into the respective sampling containers, which have also been triple rinsed with sample water. Water samples are to contain only liquids (no sludges or sediments). Preservatives will not be added prior to rinsing.

- The sample will be collected in such a manner as to prevent agitation of the water, which promotes the loss of volatile organics and increases the dissolved oxygen content. When more than one sample is to be collected from a brook, the sampling should be done downstream first and the samplers should move upstream.

- Samples to be analyzed for volatile organics will have no headspace (or bubbles) in the sample jar, will be handled as little as possible, and, if applicable, will be taken away from areas of turbulence (e.g., in streams). The VOA bottle will be immersed directly into the medium to be sampled and filled. Preservatives will be added to the VOA bottles in such a way that the appropriate pH is met prior to capping the bottles. The order of collection following VOA and TPHC is, typically, extractables, metals, explosives, and water quality parameters.

- To avoid agitation of the sample and possible cross contamination, preservation of the sample to the appropriate pH will be checked by using a separate bottle prior to actual sampling for volatile and TPHC analysis. A representative sample for the matrix and site will be collected, an appropriate amount of preservative will be added (i.e., two to three drops for VOCs and one to two mL for TPHC), the container shaken, and the pH tested with pH paper. Once the proper level of preservative is determined in the test bottle, that amount of preservative will be added to the rinsed VOA sample bottle. For other analyses, the proper preservative will be added, the sample capped and shaken, and the pH checked by pouring a very small amount of sample into a separate disposable container and using pH paper on the sample aliquot.

- Other samples will be collected in a pre-cleaned wide-mouthed bottle and transferred into 1/2-gallon glass bottles and other appropriate bottles required for chemical analyses. The wide-mouthed bottle will be refilled as many times as necessary to fill all required bottles.

- The temperature, pH, dissolved oxygen, and specific conductance of the water will be measured in the field.

- Any observable physical characteristics of the water (e.g., color, odor, turbidity) will be recorded in the field log book as it is being sampled.

- Sample bottles will be wiped dry after being capped and placed in plastic bags to be shipped for analyses.

- Weather conditions at the time of sampling (e.g., air temperature, wind and sky conditions, precipitation) will be recorded in the field log book.

3.6.2 Sediment Sampling

Sediment samples will be collected from wetlands adjacent to SA 26. Zulu. A surface water sample and a sediment sample will be collected from each location.

- o All samples shall be collected from areas of deposition when sampling flowing water (i.e. streams, rivers, and brooks).

- o All samples will, to the extent possible, contain no less than 30 percent solids. Exceptions may occur when sampling soft muds or organic (peat) deposits.

- o Care will be taken that the appropriate number of pre-cleaned sample bottles are transported to the field. See Section 4 and Table 4-2 for sample containers, volumes, and preservatives necessary for the sediment samples.

- o Labels will be placed on pre-cleaned sample bottles prior to collection, if possible. Sample labels will be filled out with waterproof ink and will include the sampler name, sample identification, sample location, date, and analysis to be performed. The actual time of collection will be added after the sample is collected.

- o The sampling area should be cleaned of vegetation and debris by using a stainless steel knife to cut through the vegetation as needed.

- o VOA and TPHC samples will be collected first and directly placed into the respective containers. The order of sample collection following VOA and TPHC collection is, typically, extractables, metals, explosives, and TOC.

- o After collecting VOC and TPHC samples, using a clean, disposable stainless steel spoon, sediment samples will be scraped from the sample area in volumes large enough to fill the required number of containers and homogenized in a stainless steel bowl prior to being placed in the sample jars.

- o To prevent cross-contamination, stainless steel spoons will not be reused.

- o Any observable physical characteristics of the sediment as it is being sampled (e.g., color, odor, physical state) will be recorded in the field log book.

- o All pertinent weather information at the time of sampling, such as air temperature, wind and sky conditions, and precipitation, will be recorded in the field log book.

3.7 SOIL SAMPLING

3.7.1 Surface Soil Sampling

Surface soil samples will only be collected from two of the six SI sites: SAs 24 and 32. The soil samples will be collected from a depth of 0 to 6 inches from each sample location. Soil samples will be collected according to the following procedures:

- Care will be taken that the appropriate number of pre-cleaned sample bottles, including preservatives, are transported to field. See Section 4 and Table 4-2 for types of sample containers, volumes, and preservatives necessary for collecting the samples.

- Labels will be placed on pre-cleaned sample bottles prior to collection, if possible. Sample labels will be filled out with waterproof ink and will include the sampler name, sample identification, sample location, date, and analysis to be performed. The actual time of collection will be added after collection.

- The sampling area should be cleaned of vegetation and debris by using a stainless steel knife to cut through the vegetation as needed.

- Using a clean, disposable stainless steel spoon, soil samples will be scraped from the ground surface over an area large enough to fill the required volume of samples.

- Leaves, roots, sticks, and rocks will be avoided.

- Soils for VOA and TPHC analysis will be collected first and placed directly into their containers. The matrix for the remaining samples will be homogenized in a stainless steel bowl prior to being placed in the sample jars. The order of collection following volatile and TPHC is, typically, extractables, metals, explosives, and TOC.

- Stainless steel spoons and knives will be discarded or decontaminated to avoid cross-contamination.

- Any observable physical characteristics of the soil as it is being sampled (e.g., color, odor, physical state) will be recorded in the field log book.

- All pertinent weather information at the time of sampling, such as air temperature, wind and sky conditions, and precipitation, will be recorded in the field log book.

3.7.2 Subsurface Soil Sampling

Subsurface soil samples will be collected from three of the six SI sites: SAs 15, 26, and 48. The soil samples will be collected from 5-foot intervals throughout each boring. Soil samples will be collected according to the following procedures:

- Care will be taken that the appropriate number of pre-cleaned sample bottles, including preservations are transported to field. See Section 4 and Table 4-2 for types of sample containers, volumes, and preservatives necessary for collecting the samples.

- Labels will be placed on pre-cleaned sample bottles prior to collection, if possible. Sample labels will be filled out with waterproof ink and will include sampler name, sample identification, sample location, date, and analysis to be performed. The actual time of collection will be added after collection.

- The sampling tool will be steel split spoons, advanced in front of the advancing auger. The split spoons will be decontaminated after each use.

- The sample tool will be removed from the drilling area and the ends unscrewed. While the sides are being separated, the sample will be monitored with field survey equipment as quickly as possible.

- The lithology of the entire sample will be noted along with visual observation. The sampling interval will be selected and the outer surface, where it was in contact with the split spoon, will be scraped or peeled to expose new sediments.

- Using a clean, stainless steel spoon, soil will be directly transferred to sample containers for volatile organic and TPHC analysis; the remaining soil will be homogenized in a stainless steel pan for the remaining sample volumes. Samples for volatile and TPHC analysis will be collected first to avoid loss of VOCs. The order of collection following volatile and TPHC is, typically, extractables, metals, and explosives.

- Stainless steel spoons and knives will be either discarded or decontaminated to avoid cross-contamination.

- Any observable physical characteristics of the soil as it is being sampled (e.g., color, odor, physical state) will be recorded in the field log book.

- All pertinent weather information at the time of sampling, such as air temperature, wind and sky conditions, and precipitation, will be recorded in the field log book.

3.8 HYDRAULIC CONDUCTIVITY (SLUG) TESTING

In-situ hydraulic conductivity values for the geologic units screened by the monitoring wells will be obtained by slug testing the existing and newly completed monitoring wells using the methodology described below. Slug testing involves displacing water in a monitoring well and measuring the rate at which the water level recovers to static conditions.

The slugs will be made from new PVC casing which will be sealed at both ends and weighted with quartz sand placed inside. The sizes of the slugs to be used are 5-foot or 2-foot lengths by 1.25 inch outer diameter for the 2-inch monitoring wells and 5-foot length by 1.5 inch outside diameter for 4-inch monitoring wells.

At each of the seven newly installed SI monitoring wells and four at SA 25 and three at SA 48, the inner tubing will be removed prior to testing if it is present. Depth to water and total well depth will be measured using an audible electronic water level meter. Also, an OVA will be used to screen all monitoring wells upon opening. These measurements will be used to determine the length of the water column and determine the appropriate slug length. The water level, total depth and slug size will be recorded on a separate data sheet for each well. Some locations may have insufficient water (less than three feet) to run a slug test.

An in-situ Hermit 2000 Data Logger and pressure transducer system (e.g., 10 or 20 pounds per square inch transducers) will be used to record each test. Prior to running any tests, the scale factor, linearity, and offset will be set on the data logger according to the specifications of the transducer being used. This transducer will be labeled Number 1 and will always be used as input 1. Additionally, other settings such as rate, reference point, and test type will be set prior to any testing. Once these parameters have been set, they will not need to be reset between tests.

All instruments to be placed in a monitoring well will be rinsed with distilled water before placement. The transducer probe, which is about 7 inches in length, cannot fit inside of a 2-inch well adjacent to the slug. It must be placed below it. The transducer probe will be lowered to the bottom of the monitoring well and then raised a minimum of several inches, the amount depending on the depth of water present in the well. The rope connected to the slug will be carefully measured to a length that allows the slug to be completely submerged while allowing enough room for the transducer probe below.

At each well location, the test number will be entered into the data logger and recorded on the data sheet. The slug will then be lowered into the well but above the water level. The data logger reference value will then be set to zero. The water level as read by the transducer will be checked to ensure that the water level is stable and drawdown is zero. If the drawdown is not zero, the reference will be reset and rechecked until a zero drawdown value is obtained. The static water level, drawdown (zero), and time will be recorded just before the test begins. The slug will then be lowered quickly but steadily into the water at the same time the test has been started on the data logger. The data logger will measure falling head values during the "slug in" testing. After the third log cycle is complete, the water levels as recorded by the data logger will be read. After a minimum recovery of 90 percent or 1 hour run time, the head level, drawdown, and time will be noted. "Slug out" testing will then be performed. As the slug is removed, the start/stop button will be depressed on the data logger. This causes the data logger to record and print out the data from the "slug out" test separately for "slug in" data without changing the test number. After 90 percent recovery is obtained or 1 hour has passed, the head value, drawdown, and time will be noted and the test will be stopped. All instruments will be rinsed with distilled water upon removal from the well. Any tubing removed from the well will be washed with distilled water and placed back in the well.

Since the data logger can only hold 10 tests, the data will be downloaded periodically to a computer file and/or printed out on a field printer. The printed data will be labeled with the corresponding monitoring well number. The data will be briefly reviewed to ensure that the data was collected properly and that the results are technically within the expected range. The data will be entered into computer software programs designed to match the data and determine the hydraulic conductivity. Slug test data for unconfined aquifers will be analyzed using methods described by Bouwer and Rice (1976). This is expected to be true of all Fort Devens wells.

Appropriate protective equipment such as gloves, will be used for personnel handling the slugs and instruments in contact with groundwater.

3.9 WELL ELEVATION AND LOCATION SURVEY

Each of the SI wells, will be topographically referenced by a licensed surveyor to within 1.0 feet of its coordinates based on the Massachusetts Coordinate system grid. Furthermore, the elevation of each borehole, at ground surface, and the top of each well casing will be surveyed to .05 feet referenced to the National Geodetic Vertical Datum of 1929. The survey data will be recorded in accordance with USATHAMA (1987) geotechnical requirements (see Appendix A).

3.10 DECONTAMINATION

Sampling methods and equipment have been chosen to minimize decontamination requirements and prevent the possibility of cross-contamination. Non-disposable equipment will be decontaminated between discrete sampling locations. All drilling equipment will be decontaminated prior to drilling, after drilling each monitoring well, and after the completion of all monitoring wells. Specific attention will be given to the drilling assembly and augers. PVC casing and screens will be kept in sealed containers and cleaned with a high-pressure washer prior to use. Drilling equipment decontamination will consist of:

- o high-pressure cleaning;
- o scrubbing with brushes, if soil remains on equipment; and
- o high-pressure rinse.

Split spoons and other non-disposable equipment will be decontaminated between each split spoon sampling event. If there is no evidence of contamination and no subsurface soil samples will be collected, the split spoons will be decontaminated as follows:

- o scrubbing with brushes;
- o triple rinsing with USATHAMA approved water; and
- o air drying.

A temporary decontamination pad will be constructed at the three SI drilling sites, SAs 15, 25, and 48, using an area approximately 12 feet by 12 feet with a defined perimeter approximately 6 inches high, lined with heavy plastic sheeting to collect decontamination waters and sediments. The primary purpose of the pad will be to decontaminate heavy equipment such as augers, well casings, and screens.

If any evidence of contamination, either by visual observation or through OVA screening showing readings greater than 10 ppm, is noted on material generated during field activities or decontamination procedures, such as protective clothing, plastic sheeting, and decontamination water will be drummed on-site and labeled.

All drummed material generated from the E & E field activities will be properly labeled with the following information:

- o Site Name,
- o Location,
- o Contents,
- o ID,
- o Date of Accumulation,
- o Sample ID, and
- o Sampler.

All the drums will be stored in a secure storage area at Fort Devens (SA 22, Building 1650, Hazardous Waste Storage Facility). The storage area and transportation of drums will be coordinated with Mark Bozer, Fort Devens Hazardous Material Specialist.

3.11 CONTROL AND DISPOSAL OF INVESTIGATION-DERIVED MATERIAL

As part of the SI, a certain amount of material will be generated in association with personal protection, sample handling, multimedia sampling, soil boring, well installation, well development, well purging, and decontamination. Every effort will be taken to minimize the material generated. The majority of the material is uncontaminated but some material will come in contact with media suspected to be contaminated.

In the field, decontamination of augers and drilling tools will be done with high-pressure water rinses as described in Section 3.10. All drill cuttings and development and purge water will be tested with an organic vapor detector using head space procedures. All investigation-derived material (water and/or soils) with readings above 10 ppm will be containerized in 55-gallon steel drums. When no contamination is detected, uncontaminated cuttings, fluids and sediments native to the immediate area will be returned to the local setting.

The following criteria will be used to classify and handle drummed cuttings, purge waters, and decontamination water that has been transported to the Fort Devens Hazardous Waste Storage Facility (Building 1650).

3.11.1 Screening

- o All materials will be screened using a OVA or PID; any materials exceeding 10 ppm will be containerized and further tested as described below.

- o OVA/PID instruments will be calibrated at least daily in accordance with manufacturer's directions.

- o All OVA/PID readings will be performed using a headspace, field analysis procedure.

- o Samples will be placed in glass containers; the container mouth will be covered with aluminum foil and capped.

- o Samples will be allowed to stabilize at a temperature of at least 20 degrees C° for at least 45 minutes.

- o The sample container lid will be removed, exposing the inner, aluminum foil cover. The foil cover will be pierced with the OVA/PID probe to measure the total organic vapor concentration in the sample headspace.

- o For well and soil borings, the sample will be collected from the split-spoon samples obtained for each 5-foot auger flight interval. Boring soils produced will be segregated in separate piles corresponding to each auger flight until OVA/PID analyses are obtained for classification.

- For well development and purge waters, the water will be collected in 55-gallon drums. One sample for OVA/PID evaluation will be obtained from each drum.

- For decontamination water, at least one sample for evaluation will be collected from the decontamination pad prior to any discharge being permitted from the pad.

3.11.2 Material Handling

- Soils/liquids exceeding 10 ppm OVA/PID readings will be containerized for further testing described below.

- Soils and water whose corresponding OVA/PID readings are 10 ppm or less will be disposed of at the site of generation. Water will be discharged to the ground in a manner to minimize surface run-off.

3.11.3 Confirmatory Testing

- Each container of soil/water that failed the PID screening criteria will be sampled in accordance with USEPA methods (SW-846), and samples will be analyzed for the four hazardous waste characteristics (40 CFR 261 Subpart C):

  - TCLP
  - Ignitability
  - Corrosivity
  - Reactivity

- USEPA analytical methods (SW-846) will be used for RCRA characteristics (ignitability, corrosivity, and reactivity).

- TCLP extraction will be performed by the method described in 40 CFR Part 261, Appendix II, Volume 55, No. 126, June 29, 1990. TCLP extract of waste samples will be analyzed for the 39 hazardous constituents.

3.11.4 Handling Containerized Waste

Any container contents that fail any of the four test methodologies will be handled as RCRA hazardous wastes. The container(s) will be transported for temporary on-post storage as directed by the Fort Devens Remedial Project Manager (RPM). Fort Devens will accept responsibility for arranging transportation and disposal of these materials in accordance with RCRA, State, and Army regulations.

Any container whose contents pass all of the four RCRA Hazardous Waste Characteristic tests will be handled as follows:

- o Solids will be transported at the Fort Devens RPM's direction to Shepley's Hill Landfill for disposal.

- o Liquids that have TCLP results at or less than 100 times corresponding Safe Drinking Water Act (SDWA) standards will be transported at the Fort Devens RPM's direction for discharge to the installation's sanitary wastewater treatment system. The rate of discharge to the treatment system will be limited to a maximum of 5,000 gallons per day.

3.11.5 Responsibilities

E & E will be responsible for providing all material, labor, and equipment necessary to perform, and for performing, the requirements of this memo, including:

- o All OVA/PID sampling and screening.

- o All containerization and providing all containers.

- o All transportation of containerized materials to Fort Devens storage and disposal sites.

- o All sampling and analyses for the RCRA Characteristics.

- o Numbering and labeling samples and containers in a manner that will assure correlation of laboratory results with the corresponding container, well/boring number, and SA number from which the sample was obtained.

- o Timely transmittal of analytical results (include OVA/PID results) to USATHAMA and Fort Devens within a maximum of 45 days from the data of sample collection.

4. PREPARATION FOR SAMPLING

4.1 COORDINATION WITH ANALYTICAL LABORATORY

The samples collected from various media will be sent to the Arthur D. Little, Inc. (ADL) laboratory in nearby Cambridge, Massachusetts. ADL is a USATHAMA certified laboratory, which is also certified under the Commonwealth of Massachusetts, DEP, and the Utah Department of Health. Necessary arrangements and coordination will be made through the Site Manager or other task leaders within the laboratory to ensure that all samples are delivered within 24 hours of sample collection. The field sampling schedule at the Fort Devens site will take into account the laboratory capacity to prevent overloading.

4.2 SAMPLE CONTAINERS

The sample containers, volumes, preservatives, and holding times required for the SI field sampling activities at the Fort Devens site are contained on Tables 4-1 and 4-2. Pre-washed, certified laboratory containers will be acquired from ADL for sampling at the site.

4.3 MAJOR SAMPLING EQUIPMENT

All instruments and equipment used during sampling will be operated, calibrated, and maintained according to the manual of manufacturer's guidelines and recommendations as well as criteria set forth in the applicable analytical methodology references. Operation, calibration, and maintenance of the field equipment will be performed by personnel properly trained in these procedures. Documentation of all routine and special maintenance and calibration information will be maintained in an appropriate logbook or reference file, and will be available on request. Table 4-3 lists the major instruments to be used for sampling at the Fort Devens SI landfill sites.

4.4 SAMPLE DATA ENTRY

Each sample sent for analysis will have a unique sample identification number written on the sample. These data, in specific formats, are required for entry of the sample into the Installation Restoration Data Management Information System (IRDMIS). The sample identification number will contain a four-character code identifying the category of sample collected (SITE TYPE), followed by a second code, no more than 10 characters long including extensions that identify the site, sample location, and sample number (SITE ID). No two sample identification numbers will be the same.

Table 4-1

SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES FOR WATER SAMPLES

Type of Analysis	Type and Size of Container	Number of Containers and Sample Volume (per sample)	Preservation	Maximum Holding Time
TCL				
Purgable Volatile Organic Compounds (VOA)	40-ml glass vial	Two (2); fill completely, no air space	Hydrochloric Acid to pH <2 and cool to 4°C (ice in cooler)	7 days
Extractable Base/Neutral/Acid (BNA) Pesticide/PCB Compounds	1/2 gallon bottle with Teflon-lined cap	Two (2); total volume approx. 1 gallon, fill completely	Cool to 4°C (ice in cooler)	Must be extracted in 7 days; analyzed within 40 days of extraction
TAL	1 liter polyethylene bottle with polyethylene cap	One (1); fill 7/8 full	Nitric acid to pH < 2 (1.5 ml HNO_3 per liter)	6 months (mercury holding time - 28 days)
Explosives	1/2 gallon bottle with Teflon-lined cap	One (1); total volume approx. 1/2 gallon, fill completely	Cool to 4°C (ice in cooler)	Must be extracted in 56 days; analyzed within 40 days of extraction
TPHC	1 liter amber glass bottle with Teflon-lined cap	One (1); fill completely, no air space	Sulfuric Acid to pH <2 and cool to 4°C (in ice cooler)	28 days
TOC	1 liter amber glass bottle with Teflon-lined cap	One (1); fill completely	H_2SO_4 Cool to 4°C (ice in cooler)	28 days

Table 4-1 (Cont.)

SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES FOR WATER SAMPLES

Type of Analysis	Type and Size of Container	Number of Containers and Sample Volume (per sample)	Preservation	Maximum Holding Time
Anions	1 liter polyethylene bottle with polyethylene cap	one (1); fill half full	Cool to 4°C (ice in cooler)	48 hours
Hardness[a]	1 liter polyethylene bottle with polyethylene cap	one (1); fill 3/4 full	H_2SO_4 to pH <2 cool to 4°C (ice in cooler)	6 months
TKN[a]	1 liter polyethylene bottle with polyethylene cap	one (1); fill 3/4 full	H_2SO_4 to pH <2 cool to 4°C (ice in cooler)	28 days
Alkalinity (bicarbonate)	1 liter polyethylene bottle with polyethylene cap	one (1); fill completely	Cool to 4°C (ice in cooler)	14 days

Note: All sample bottles will be prepared and all samples will be collected, handled, and analyzed according to the latest USATHAMA Installation Restoration Quality Assurance Plan (IRQAP) requirements.

TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons
TOC: Total Organic Carbon
Anions/Cations: chloride, sulfate, nitrate, (Cations: calcium, potassium, and magnesium are included in TAL)
TKN: Total Kjeldhal Nitrogen

[a]Samples for hardness and TKN may be collected in the same container

Table 4-2

SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES FOR SOIL/SEDIMENT SAMPLES

Type of Analysis	Type and Size of Container	Number of Containers and Sample Volume (per sample)	Preservation	Maximum Holding Time
TCL				
Purgable Volatile Organic Compounds	4- or 8-oz. glass jar with Teflon-lined cap	Two (2); fill completely no air space	Cool to 4°C (ince in cooler)	7 days
Extractable Base/Neutral/Acid (BNA) Pesticide/PCB Compounds	8-oz glass jar with Teflon-lined cap	Two (2); fill completely	Cool to 4°C (ice in cooler)	Must be extracted in 7 days of collection, analyzed within 40 days of extraction
TAL	8-oz glass jar with Teflon-lined cap	One (1); fill 1/2 full	Cool to 4°C (ice in cooler)	6 months (mercury holding time - 28 days)
Explosives	8-oz glass jar with Teflon-lined cap	One (1); fill 1/2 full	Cool to 4°C (ice in cooler)	Must be extracted in 56 days of collection and analyzed within 40 days of extraction
TPHC	8-oz glass jar with Teflon-lined cap	One (1); fill completely	Cool to 4°C (ice in cooler)	14 days or within 24 hours if sulfide is present
TOC	8-oz glass jar with Teflon-lined cap	One (1); fill completely	Cool to 4°C (ice in cooler)	28 days

Note: All sample bottles will be prepared and all samples will be collected, handled, and analyzed according to the latest USATHAMA IRQAP requirements.

TCL: Target Compound List
TAL: Target Analyte List
TPHC: Total Petroleum Hydrocarbons
TOC: Total Organic Carbon

Table 4-3

MAJOR INSTRUMENTS TO BE USED FOR FIELD SAMPLING AND ANALYSIS PROGRAM

- MSA 260 0_x Explosimeter
- Organic Vapor Analyzer Foxboro Century System (128)
- Photo Ionization Detector, HNu Mode PI101
- pH/Temperature/Conductivity Meter
  - Portable, Fisher Model 13-641-739
- Unimag Geonics EM-31 Ground Conductivity Meter
- EE&G Magnetometer, Model G856
- UXO clearance equipment
- OMNI Polycorder Data Logger Model 516B.
- Complete drilling equipment will be provided by the drilling subcontractor.
- Sample containers will be provided by ADL.
- ADL maintains their own analytical lab equipment which has been detailed in their certification documents (refer to Appendix C of QAPjP).

Note: All survey equipment will be calibrated, maintained, and operated according to manufacturer's specifications and all QC protocols within the appropriate methodology (see Section 7 of QAPjP).

Both lamps (10.2 eV, 11.7 eV) will be used with the HNu Photoionizer. Isobutylene will be used as the calibration gas.

The HNu, the OVA, and the MSA 260 0_2 Explosimeter will be calibrated, at a minimum, before use each day, or as required if field problems arise.

4.5 IRDMIS DATA REQUIREMENTS

SITE TYPE designation consists of up to four characters that describe landmarks, features, or construction activities at the sample collection site. The SITE TYPE designations are required of all chemical and geotechnical record entries into the IRDMIS, except for quality control samples. USATHAMA has a pre-specified list of SITE TYPE designations that are acceptable to IRDMIS (USATHAMA, 1988). A complete description of all the SI sampling sites and sample identifications are provided in Appendix B.

Appropriate IRDMIS SITE TYPE codes for the SI include:

- BORE for borehole (SAs 15, 26, 48)
- WELL for monitoring wells (SAs 25, 48)
- POND for wetland (SA 26 surface water/sediment samples)
- AREA for surface grab samples (SAs 24, 32)

Appropriate IRDMIS SITE ID codes for the SI include:

o	LF11	=	Landfill No. 11	SA 15
o	B187	=	Bunker 187	SA 24
o	ZULU1	=	Zulu Range 1	SA 26
o	ZULU2	=	Zulu Range 2	SA 26
o	EOD	=	EOD Range	SA 25
o	DRMO	=	DRMO Yard	SA 32
o	B202	=	Building 202	SA 48

The numbers following the SITE ID indicate the sample sequence number or, in the case of soil borings, the sample group and the sample sequence number. For example, BORE LF11-1-1 represents the first soil sample from the first soil boring at Landfill No. 11.

5. FIELD PERSONNEL REQUIREMENTS

The sampling team for the field investigations will consist of three to five members, depending on the type of field work being conducted at the time, all experienced in the type of sampling activities planned at the Fort Devens SIs.

The field sampling activities will be conducted in accordance with the time schedule set in Section 5 of the SI work plan. However, the field sampling schedule may depend on weather conditions (e.g., drilling on the firing ranges cannot be conducted under wet weather conditions). If feasible, non-intrusive field work, such as a geophysical survey, will be conducted during the first event of field activity to allow time for data processing and possible use of the resulting data for subsequent field investigations.

At a minimum, a field team leader, a Field Safety Officer (FSO), and one or more team member(s) (known as recorder(s)) will be assigned to record each event of field activity. A geologist will be present to supervise the drillers and to log sediment samples. More than one recorder may be necessary if two or more types of field activities are running concurrently. The recorder's and FSO's duties may be rotated if feasible.

The field team member's duties are listed below:

- The field team leader will have the overall responsibility for the sampling team's activities. Responsibility includes relaying information to the record custodian, choosing sample location (if not already marked), directing sample gathering methods and sample quantities, and any other operations.

- The recorder will document all information in the appropriate field logs. This person will also prepare sample labels and bottles and provide other necessary support for sampling.

- The FSO will be responsible for the team's overall safety. The FSO will make the necessary measurements of initial site entry conditions and will also ensure that proper safety protocols are followed. In addition, the FSO will assist in collecting samples.

6. SI SITE MANAGEMENT

SI site management will support the field sampling and data collection activities at Fort Devens. These management tasks include mobilization, site access and control, documentation, field instrumentation, decontamination, and control and handling of investigative derived wastes.

6.1 MOBILIZATION

The major field period will commence in June and end in August 1991. The schedule of field activity has been coordinated with ADL and Fort Devens DEH to achieve the maximum productivity of the teams and meet the requirements of the Delivery Order. Figure 6-1 shows the calendar of events by task, with the expected location, while Figure 6-2 provides a description of the number of samples to be collected by calendar date. For this effort, E & E will mobilize its field teams and subcontractors. The following activities will be required for mobilization.

- Set up of field office and command post with necessary communication and power.
- Coordinate with Fort Devens DEH for access to the study areas. Obtain necessary permits and clearances to conduct work.
- Stage equipment for a drilling program. Obtain approval for sands and grouts to be used.
- Construct a decontamination pad for cleaning of all drilling and sampling equipment.
- Stage necessary materials to support sampling program such as cooler, bottles, logs, sheets.
- Brief field teams on objectives of the program and any special conduct required on military installation.
- Brief team on health and safety and any special procedures.

6.2 SITE ACCESS AND CONTROL

Public access to Landfill No. 11, the EOD Range, and the Zulu Ranges is restricted since they are all located on the South Post. Bunker 187 is restricted to all except for personnel permitted access to ammunition storage. Strictly controlled site access at the DRMO yard or Building 202 is not practical or at this time necessary. However, a safety exclusion zone will be established at each working area. An

June 2 - August 3

FT. DEVENS SI FIELD SCHEDULE

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
June 2	June 3 Geophysical Survey at LF 11	June 4	June 5	June 6	June 7	June 8
June 9	June 10	June 11	June 12	June 13	June 14	June 15
June 16	June 17 Install Wells at B202	June 18	June 19	June 20	June 21	June 22
June 23	June 24 Collect Soils at Zulu 1 & 2 for Explosives	June 25	June 26 Soil Borings at Zulu 1 *	June 27 Well Installation at EOD	June 28 Soil Gas Survey LF 11	June 29
June 30 Well Installation at EOD	July 1 Soil Boring at B202	July 2	July 3	July 4	July 5	July 6
July 7	July 8 Soil Boring at LF 11 *	July 9	July 10	July 11	July 12 Slug Test at EOD and B202	July 13
July 14 Slug Test at EOD and B202	July 15	July 16	July 17 SW/SE Sampling at Zulu 1 & 2	July 18 GW Sampling at EOD	July 19	July 20
July 21	July 22	July 23 Sampling DRMO/B202	July 24 Soil Sampling B187	July 25	July 26	July 27
July 28	July 29	July 30	July 31	Aug 1 Soil Borings at Zulu 2 *	Aug 2	Aug 3

Key: GW Groundwater Sampling SE Sediment Sampling SW Surface Water Sampling
* Sampling occurs with Soil Boring

Figure 6-1 FIELD SCHEDULE FOR FORT DEVENS SI

00310.PM4

June 23 - August 3
FT. DEVENS SI SAMPLING PLAN

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
June 23	June 24 6 SOIL FOR RESIDUAL EXPLOSIVES, ZULU RANGES	June 25	June 26 24 GEOTECH SAMPLES 1 TCLP ZULU 1 12 SOIL TCL,TAL, EXP ZULU 1	June 27 24 GEOTECH SAMPLES 1 TCLP ZULU 1 12 SOIL TCL,TAL, EXP ZULU 1	June 28 24 GEOTECH SAMPLES 1 TCLP ZULU 1 12 SOIL TCL,TAL, EXP ZULU 1	June 29
June 30	July 1	July 2 7 SOIL TPH B-202 7 GEOTECH SAMPLES	July 3	July 4	July 5	July 6
July 7	July 8	July 9 10 GEOTECH SAMPLES 20 SOIL TCL,TAL, TPH LF 11 1 TCLP LF 11	July 10	July 11 2 TCLP, LF 11 10 GEOTECH SAMPLES 20 SOIL TCL,TAL, TPH LF 11	July 12	July 13
July 14	July 15	July 16	July 17 8 SURFACE WATER TCL, TAL,TPH,EXP, HARDNESS ZULU 1 8 SEDIMENT TCL,TAL,EXP, TPH,TOC ZULU 1	July 18 4 G.WATER TCL, TAL,TPH,EXP, IONS EOD 2 S.WATER TCL, TAL,TPH,EXP, HARDNESS ZULU 2 2 SEDIMENT TCL,TAL,TPH, EXP,TOC ZULU 2	July 19	July 20
July 21	July 22	July 23 2 TCLP DRMO YARD 3 GROUND WATER TCL, TAL,TPH,IONS B-202 11 SURFACE SOIL TCL,TAL, TPH DRMO YARD	July 24 1 TCLP B187 5 SURFACE SOIL EXPL B187	July 25	July 26	July 27
July 28	July 29	July 30	July 31	Aug 1	Aug 2 20 GEOTECH SAMPLES 2 TCLP ZULU 2 30 SOIL TCL,TAL, EXP ZULU 2	Aug 3

Figure 6-2 SAMPLING SCHEDULE FOR FORT DEVENS SI

exclusion zone is entered through the support zone and a contamination reduction zone. In Section 7.1.1 of the HASP, there are definitions of each zone in this work area. All areas where contamination has been found and/or poses a potential hazard, including physical hazard (e.g., drilling equipment), will be included in the exclusion zone. This zone will be marked in the field by wooden or steel stakes and colored surveyor tape. Only project or authorized personnel will be allowed to access the exclusion zone. The appropriate protection equipment must be worn when working or visiting this zone. The level of safety protection will vary from location to location and in accordance with the type of sampling activities being performed on the basis of site history and monitoring data. The level of protection for each area may also be upgraded or downgraded as directed by the FSO. (In accordance with Appendix A in the HASP for Levels of Protection.)

6.3 DOCUMENTATION

Documentation and records of activities that occurred during the field work will be kept on-site during field operations. Data entry into log book, forms, and notebooks will be written in indelible ink and initialed by the author. Entry error in the log books or notebooks will be crossed out. Site management documentations include work plans, materials received during the field operations and site/activity log books. These are discussed in the following sections.

6.3.1 Project Plans

A copy of the SI Work Plan, SI FSP, QAPjP, HASP and CRP will be kept at the field office. These documents are necessary for reference and to ensure the field teams are following prescribed procedures and schedules. In addition, a copy of the FSP and HASP will be on site during field activities.

6.3.2 Site Logbooks

A site log book will be kept at the field offices. This logbook will be maintained daily by the field site manager with information concerning operations of the project. This information will include on-site personnel, weather, visitors, work accomplished, and any specific directions received from the client, Fort Devens DEH or other.

6.3.3 Field Logbook

Separate field logs will document the details of each activity during the investigation. The field team leader for the activity will be responsible for data entry in these logs. In conjunction with the field log, field data sheets and forms will be maintained by the field team personnel. These forms will document activities such as daily safety and health meetings, equipment calibration, borehole data, well construction, soil classification, instrument measurements, etc.

6.4 FIELD INSTRUMENTATION

Field instrumentation to support the RI Field Sampling Plan includes the following:

- o Organic Vapor Analyzer (OVA)
- o Photoionization Detector (PID)
- o O_2/Explosimeter
- o Rad-Mini
- o Electronic Water Level Meter
- o Data Logger
- o Terrain Conductivity Equipment

6.5 DECONTAMINATION

Decontamination procedures are discussed in detail in Section 3.10, and briefly summarized below. Non-disposable equipment will be decontaminated between discrete sampling locations. All drilling equipment will be decontaminated prior to drilling, after drilling each monitoring well, and after the completion of all monitoring wells. Specific attention will be given to the drilling assembly and augers. PVC casing and screens will be kept in sealed containers and cleaned with a high-pressure washer prior to use. All other material with any evidence of contamination generated during decontamination procedures will be drummed on site and labeled.

6.6 INVESTIGATION-DERIVED WASTE

As part of the SI, a certain amount of waste material will be generated in association with personal protection, sample handling, multimedia sampling, soil boring, well installation, well development, well purging, and decontamination. The majority of the waste is uncontaminated refuse, but some material will come in contact with media suspected to be contaminated.

In the field, decontamination of non-disposable equipment will be done with high-pressure water rinses. Field monitoring of the extracted material with photoionization devices, organic vapor analyzers, and by visual observations will determine if contamination is present. If contamination is observed, the material will be contained. When no contamination is detected, uncontaminated cuttings, fluids, and sediments native to the immediate area will be returned to the local setting. See Section 3.11 for identification, control of, and disposal of investigation-derived material.

6.7 WATER SOURCE

The source of any water to be used in drilling, grouting, well installation, or equipment decontamination must be approved by the Contracting Officer or COTR prior to its use. The water production well on the South Post has been identified as a possible water source for the field investigations at Fort Devens. This source will be sampled and analyzed for TCL, TAL, TOC, and TPHC. Analytical data from the well samples will be submitted to USATHAMA with the Water Approval Request Form.

7. SAMPLE HANDLING, PACKAGING, AND SHIPPING

The transportation and handling of samples collected from the Fort Devens site must be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects due to the possible hazardous nature of the samples. Regulation for packaging, labeling, and shipping hazardous materials are promulgated by the United States Department of Transportation (DOT) in the Code of Federal Regulations, 49 CFR 171 through 177. These regulations will be considered when handling the transportation of site samples.

All chain-of-custody requirements described in Section 8 will comply with standard operating procedures (SOPs) in the EPA, USATHAMA, and E & E sample handling protocols.

7.1 SAMPLE PACKAGING

Samples must be packaged carefully to avoid breakage or contamination and must be shipped to the laboratory at proper temperatures. The following sample packaging requirement will be followed when packaging Fort Devens site samples:

- Sample bottle lids must never be mixed. All sample lids must stay with the original containers.
- The sample volume level should be marked with a piece of tape or a grease pencil. This procedure will help the laboratory to determine if any leakage occurred during shipment. The label should not cover any bottle preparation QA/QC lot number.
- All sample bottles are placed in a bubblewrap plastic bag to minimize the potential for contamination from packing material and breakage.
- Shipping coolers must be partially filled with packing materials and ice, when required, to prevent the bottles from moving during shipment.
- The sample bottles must be placed in the cooler in such a way as to ensure that they do not touch one another.
- The environmental samples are to be cooled. The use of "blue ice" or some other artificial icing material is preferred. If necessary, ice may be used, provided that it is placed in plastic ziplock bags. Ice is not to be used as a substitute for packing materials.
- Any remaining space in the cooler should be filled with inert packing materials. Under no circumstances should materials such as sawdust or sand be used.

- A duplicate custody record, if required, must be placed in a plastic bag and taped to the bottom of the cooler lid. Custody seals are affixed to the sample cooler.

7.2 SHIPPING CONTAINERS

Upon completion of sample packaging, the environmental samples will be properly labeled for transport and dispatched to ADL.

- Shipping containers are to be custody sealed for shipment as appropriate. The container custody seal will consist of filament tape wrapped around the package at least twice and custody seals affixed in such a way that access to the container can be gained only by cutting the filament tape and breaking a seal.

- Field personnel will make the necessary arrangements for transportation of samples to ADL within the appropriate time frame. When custody is relinquished to a shipper, field personnel will telephone the laboratory custodian to inform him/her of the expected time of arrival of the sample shipment and to advise him/her of any time constraints on sample analysis. The laboratory should be notified as early in the week as possible, and in no case later than 3:00 p.m. on Thursday regarding samples intended for Saturday delivery.

7.3 MARKING AND LABELING

- The use of abbreviations is authorized only when specified.

- The words "This End Up" or "This Side Up" must be clearly printed on the top of the outer package. Upward pointing arrows should be placed on the sides of the package. The words "Laboratory Samples" should be printed on the top of the package.

- After a sample container has been sealed, two seals of custody are placed on the container: one on the front and one on the back. The seals are protected from accidental damage by placing strapping tape over them.

- If samples are designated as medium or high-hazard (not anticipated at Fort Devens), they must be sealed in metal paint cans, placed in the cooler with an inert absorbent, and labeled and placarded in accordance with DOT regulations.

8. SAMPLE CUSTODY

This section describes SOPs for sample identification and chain-of-custody to be utilized for all Fort Devens field activities. The purpose of these procedures is to ensure that the quality of the samples is maintained during their collection, transportation, and storage through analysis. All chain-of-custody requirements comply with SOPs consistent with EPA and USATHAMA sample handling protocols. All sample control and chain-of-custody procedures applicable to E & E and USATHAMA QA will be strictly followed during the sampling at Fort Devens SI sites.

Sample identification documents must be carefully prepared so that sample identification and chain-of-custody can be maintained and sample disposition controlled. Sample identification documents include:

- field notebooks,
- sample label,
- custody seals, and
- chain-of-custody records.

8.1 CHAIN-OF-CUSTODY

The primary objective of the chain-of-custody procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from collection to completion of all required analyses. A sample is in custody if it is:

- in someone's physical possession,
- in someone's view,
- locked up, or
- kept in a secured area that is restricted to authorized personnel.

8.1.1 Field Custody Procedures

Strict adherence to field custody procedures will be followed.

- As few persons as possible should handle samples.
- Pre-cleaned sample bottles must be obtained from either the laboratory performing the analysis or an approved retail source such as I-Chem. Coolers or boxes containing clean bottles should be sealed with a custody tape seal during transport to the field or while in storage prior to use.

- The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person or dispatched properly under chain-of-custody rules.

- The sample collector will record sample data in the field log book.

- The site team leader will determine whether proper custody procedures were followed during the field work and decide if additional samples are required.

8.1.2 Chain-of-Custody Record

The chain-of-custody record must be fully completed at least in duplicate by the field technician who has been designated by the Project Manager as responsible for sample shipment to the appropriate laboratory for analysis. In addition, if samples are known to require rapid turnaround in the laboratory because of project time constraints or analytical concerns (e.g., extraction sample or sample retention period limitations, etc.), the person completing the chain-of-custody record should note these constraints and/or other sampling-pertinent remarks in the "Remarks" section of the custody record. The QAPjP provides an example of chain-of-custody.

8.1.3 Transfer of Custody and Shipment

- The coolers in which the samples are packed must be accompanied by a chain-of-custody record. When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on the chain-of-custody record. This record documents sample custody transfer.

- Samples must be dispatched to the appropriate laboratory for analysis with a separate chain-of-custody record accompanying each shipment. Shipping containers must be sealed with custody seals for shipment to the laboratory. The method of shipment, name of courier, and other pertinent information are entered in the "Remarks" section of the chain-of-custody record.

- All shipments must be accompanied by the chain-of-custody record identifying their contents. The original record accompanies the shipment. The other copies are distributed appropriately as indicated in the bottom section of the record.

- If sent by mail, the package should be registered with return receipt requested. If sent by common carrier, a bill of lading is used. Freight bills, postal service receipts, and bills of lading are retained as part of the permanent documentation.

8.1.4 Laboratory Custody Procedures

A designated sample custodian accepts custody of the shipped samples and verifies that the sample identification number matches that on the chain-of-custody record. Pertinent information as to shipment, pick-up, and courier is entered in the "Remarks" section. The custodian for ADL will enter the sample identification number and other information into the laboratory's sample tracking system. The numbers and codes will be retained so there will be no confusion when entering data into the IRDMIS system.

8.1.5 Custody Seals

Custody seals are preprinted adhesive-backed seals with security slots designed to break if the seals are disturbed. A custody seal is placed over the cap of individual sample bottles, excluding septum capped VOA bottles, by the sampling technician. Sample shipping containers (coolers, cardboard boxes, etc., as appropriate) are sealed in as many places as necessary to ensure security. Seals must be signed and dated before use. On receipt at the laboratory, the custodian must check (and certify by completing logbook entries) that seals on boxes and bottles are intact. Strapping tape should be placed over the seals to ensure that seals are not accidentally broken during shipment.

8.2 DOCUMENTATION

8.2.1 Sample Identification

All samples collected from the project sites will be identified as to SITE TYPE and SITE ID codes using the following format on a label or tag fixed to the sample container. For a listing of all the SI samples, see Appendix B.

SITE TYPE - This set of four initials indicates the site type of the sample collected:

BORE = Soil Boring
WELL = Well Sample
AREA = Surface Soil
POND = Wetland

SITE ID - Is a series of initials and numbers that identify which site the sample comes from, which number sample it is, and in some cases whether it is a surface water or sediment sample. No two sample identification numbers will be the same; however, sample ID numbers may be the same.

LF11 = Landfill 11
ZULU1 = Zulu Range 1
EOD = EOD Range
B202 = Building 202
B187 = Bunker 187

ZULU2 = Zulu Range 2
DRMO = DRMO Yard

The numbers following the Site ID indicate the sample sequence number or, in the case of soil borings, the sample group and the sample sequence number. For example, BORE LF11-1-1 represents the first soil sample from the first soil boring at Landfill No. 11. Actual sample location, sample depth, and notation as grab or composite will be recorded in the logbooks and entered into the IRDMIS system.

Each sample will be labeled, chemically preserved, if required, and sealed immediately after collection. To minimize handling of sample containers, labels will be filled out prior to sample collection. The sample label will be filled out using waterproof ink and will be firmly affixed to the sample containers and protected with clear Mylar tape. The sample label will provide the following information:

- name of sampler,
- date and time of collection,
- site type and ID,
- analysis required,
- pH, and
- preservative.

8.2.2 Daily Logs

Daily logs and data forms are necessary to provide sufficient data and observations to enable participants to reconstruct events that occurred during the project and refresh the memory of the field personnel if called upon to give testimony during legal proceedings. All daily logs will be kept in a bound, waterproof notebook containing numbered pages. All entries will be made in waterproof ink, dated, and signed. No pages will be removed for any reason. Corrections will be made according to the procedures given at the end of this section. The daily logs will include a Site Log and a Task Log.

The Site Log is the responsibility of the site team leader and will include a complete summary of the day's activity at the site.

The Task Log for the site will include:

- Name of person making entry (signature).
- Names of team members on-site.

- o Levels of personnel protection:
  - level of protection originally used;
  - changes in protection, if required; and
  - reasons for changes.
- o Time spent collecting samples.
- o Documentation on samples taken, including:
  - sampling location and depth station numbers;
  - sampling date and time, sampling personnel;
  - type of sample (grab, composite, etc.); and
  - sample matrix.
- o On-site measurement data including instrumentation serial numbers and calibration history.
- o Field observations and remarks.
- o Weather conditions, wind direction, etc.
- o Unusual circumstances or difficulties.
- o Initials of person recording the information.

8.2.3 Corrections to Documentation

8.2.3.1 Notebook

As with any data logbook, no pages will be removed from the notebook for any reason. If corrections are necessary, these must be made by drawing a single line through the original entry (so that the original entry can still be read) and writing the corrected entry alongside. The correction must be initialed and dated. Most corrected errors will require a footnote explaining the correction.

8.2.3.2 Sampling Forms

As previously stated, all sample identification tags, chain-of-custody records, and other forms must be written in waterproof ink. If an error is made on a document assigned to one individual, that individual may make corrections simply by crossing a line through the error and entering the corrected information. The incorrect information should not be obliterated. Any subsequent error discovered on a document should be corrected by the person who made the entry. All corrections must be initialed and dated.

8.2.4 Photographs

Photographs will be taken as directed by the Project Manager or team leader. Documentation of a photograph is crucial to its validity as a representation of an existing situation. The following information will be noted in the Task Log concerning photographs:

- date, time, location photograph was taken;
- photographer (signature);
- weather conditions;
- description of photograph taken;
- reasons why photograph was taken; and
- sequential number of the photograph, and the film roll number, and camera lens system used.

After the photographs have been developed, the information recorded in the field notebook should be transferred to the back of the photographs.

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APPENDIX A

USATHAMA GEOTECHNICAL REQUIREMENTS

USATHAMA

U.S. Army Toxic and Hazardous Materials Agency

GEOTECHNICAL REQUIREMENTS

FOR

DRILLING, MONITOR WELLS, DATA ACQUISITION, AND REPORTS

MARCH 1987

DEPARTMENT OF THE ARMY

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY

ABERDEEN PROVING GROUND, MD 21010-5401

US ARMY
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D I S C L A I M E R

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I. OBJECTIVE.

The objective of these requirements is to set forth the geotechnical criteria and procedures of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). These requirements are used in technical support of the Contracting Officer for geotechnical exploration and reporting. The application of geotechnology to environmental programs should begin with project conception. The Geotechnical Requirements join this application during the design of the field program, after the initial magnitude of the study has been determined and tentative well sites selected. The application of these requirements is intended to provide acceptable technical data and tracking procedures to accurately obtain, describe, and evaluate representative samples of the subsurface environment in terms of geology, hydrology, and groundwater chemistry. This sample-specific data can be merged with site-operational knowledge to characterize and appraise the contaminant potential of the site.

II. GENERAL POLICY.

A. The Geotechnical Requirements shall be a part of and attached to each Request for Proposal or Quotation (RFP/RFQ) involving subsurface exploration and resulting contracts and/or task orders. A verbatim copy of these Requirements, modified by only the initial contract or task order and subsequent amendments, shall be made part of and attached to the contractor's Technical Plan (or equivalent document).

B. The Geotechnical Requirements were written as a generalized document. Application to a specific contract or task is likely to generate obvious or subtle conflicts. When conflicts exist between the Geotechnical Requirements and specific contractual documents; i.e., the RFP/RFQ, contract, task order, or contractual amendments, the latest contractual documents shall take precedence.

C. Technically, the Contracting Officer is the only Governmental agent who has the authority to change a given contract. Some administrative aspects of this authority are usually delegated in writing to certain USATHAMA personnel serving as Contracting Officer's Representatives (COR). These aspects include the approval for use of specified items; e.g., the drilling water, granular filter pack, bentonite, etc., as discussed in the Geotechnical Requirements. USATHAMA's approval of these items is performed through and under the authority of the Contracting Officer. Therefore, the contractor's requests for approval of, variance from, or notification of problems with the technical items within these Geotechnical Requirements shall be directly sent from the contractor to the USATHAMA COR responsible for that contract or task.

D. Any deviation from the contract shall be requested of and approved by the Contracting Officer. Deviations approved for a given contract or task shall not be applicable to any other contract or task unless specified in the approval.

E. These requirements will be updated as required incorporating new technology, experience, and policy.

III. SPECIFIC ELEMENTS.

A. Drilling Operations.

1. Drilling Methods.

a. The object of drilling method selection is to use that technique which:

(1) Minimizes subsurface contamination or cross contamination.

(2) Provides representative data.

(3) Minimizes drilling costs.

b. To this end, the following drilling methods are typically used:

(1) Hollow-stem augers.

(2) Water/mud rotary.

(3) Cable tool/churn drill.

(4) Air rotary.

c. Of these, air rotary is the least desirable and is further discussed in section III.A.2. Other methods, like reverse circulation, may have applicability in certain cases. Unless specified in the RFP/RFQ, the drilling method shall be suggested and described by the contractor in his RFP/RFQ response and/or technical plan, for the Contracting Officer's consideration and approval.

2. Air Rotary.

a. Air systems, including bottled gas, shall not be used for drilling, well installation, well development, presample purging, or sampling unless specified in the statement of work. However, when alternative bids or proposals are allowed, the contractor may present as part of the bid/proposal package an alternative using an air system(s) for a given operation(s). The contractor's alternative shall include:

(1) Situation.

(2) Recommendation.

(3) The effect of usage upon groundwater and soil chemical analyses.

(4) Alternatives with cost savings or increases, as appropriate.

b. The above item shall be quantified, costed (in the appropriate section of the bid/proposal package), and shall incorporate the appropriate criteria discussed in paragraph III.A.2.c. below. Consideration and a recommendation by USATHAMA will be made during the course of bid/proposal evaluation, prior to contract award.

c. In general, air system plans shall:

(1) Specify the type of air compressor and lubricating oil and require a pint sample of each oil be retained by the contractor, along with a record of oil loss (on the boring log), for evaluation in the event of future problems. The oil sample(s) may be disposed of upon contract/task completion.

(2) Require an air line oil filter and that the filter be changed per manufacturer's recommendation during operation with a record kept (on the boring log) of this maintenance. More frequent changes shall be made if oil is visibly detected in the filtered air.

(3) Prohibit the use of any additive except approved water (III.A.10.b.) for dust control and cuttings removal.

(4) Detail the use of any downhole hammer/bit with emphasis upon those procedures to be taken to preclude residual groundwater sample contamination caused by the lubrication of the downhole equipment.

d. Air usage shall be fully described in the log or associated geotechnical report to include equipment description(s), manufacturer(s), model(s), air pressures used, frequency of oil filter change, and evaluations of the system performance, both design and actual.

3. Recirculation Tanks and Sumps. Portable recirculation tanks are suggested for mud/water rotary operations and similar requirements. The use of dug sumps/pits (lined or unlined) is expressly prohibited.

4. Site Geologist. A geologist shall be present and responsible at each operating drill rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of that rig. Each geologist shall be responsible for only one operating rig. Each geologist shall have onsite sufficient tools and professional equipment in operable condition to efficiently perform his/her duties as outlined in these Geotechnical Requirements and other contractual documents. Items in the possession of each geologist shall include, as a minimum: a copy of the geotechnical portion of the statement of work, the USATHAMA-approved Technical Plan (or equivalent) which incorporates these Geotechnical Requirements, the approved Safety Plan (approved after contract award), a 10X (minimum) hand lens, and a weighted (with steel or iron) tape(s), long enough to measure the deepest well within the contract, heavy enough to reach that depth, and small enough to readily fit within the annulus between the well and drill casing. Each geologist shall also have onsite a water level measuring device, preferably electrical.

5. Permits, Rights-of-Entry, and Licenses. The contractor shall be responsible for securing and complying with any and all boring or well drilling permits and/or procedures required by state or local authorities and

for determining and complying with any and all state or local regulations with regard to the submission of well logs, samples, etc. Submission of these items to state or local authorities shall be coordinated through USATHAMA. The contractor shall telephonically notify USATHAMA immediately in the event of any apparent discrepancy between contractual and state or local requirements. Notification shall include the nature of the discrepancy; the name, agency, and telephone number of the person noting the discrepancy; and the current status. Any rights-of-entry (for off-post drilling) will be obtained for and supplied to the contractor by the Contracting Officer. The contractor shall ensure that all drilling of boreholes, well installation, and topographic surveying is accomplished by companies appropriately licensed in the project State. A copy of each current license (denoting expiration date) shall be provided in the contractor's Technical Plan. If the project State does not require a licensed driller for this project, then a statement to that effect shall be included in the technical plan.

6. Drilling Safety and Underground Utility Detection. The contractor shall be responsible for determining and complying with any and all (to include host installation) regulations, requirements, and permits with regard to drilling safety and underground utility detection. The contractor shall include a discussion of his actions with regard to these items in his proposal and Safety Plan (also see III.A.12.b., III.A.12.d., and III.G.).

7. Lubricants. Only petroleum jelly, teflon tape, lithium grease, or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Additives containing lead or copper shall not be used. Any hydraulic or other fluids in the drilling rig, pumps, or other field equipment/vehicles shall NOT contain any polychlorinated biphenyls (PCBs).

8. Surface Runoff. Surface runoff; e.g., precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks, shall not enter any boring or well either during or after drilling/well construction. To help preclude this, the use of starter casing, recirculation tanks, berms about the borehole, and surficial bentonite packs, as appropriate, are suggested.

9. Antifreeze. If antifreeze is added to any pump, hose, etc., in an area in contact with drilling fluid, this antifreeze shall be completely purged prior to the equipment's use in drilling, mud mixing, or any other part of the overall drilling operation. Only antifreeze without rust inhibitors and/or sealants shall be used. The contractor shall note on the boring log the dates, reasons, quantities, and brand names of antifreeze per above.

10. Materials.

a. Bentonite is the only drilling fluid additive allowed. No organic additives shall be used. Exception is usually made for some high yield bentonites to which the manufacturer has added a small quantity of polymer. The use of any bentonite must be approved by the Contracting Officer prior to the arrival onsite of the drilling equipment (rigs). This includes bentonites (powders, pellets, etc.) intended for drilling mud, grout, seals, etc. The following data, III.A.10.a.(1)-(5), shall be submitted in writing (see Figure 1) through USATHAMA to the Contracting Officer as part of the approval request. Allow six working days from the time of receipt by USATHAMA for request evaluation and recommendation.

(1) Brand names(s).

(2) Manufacturer(s).

(3) Manufacturer's address(es) and telephone number(s).

(4) Product description(s) from package label(s)/manufacturer's brochure(s).

(5) Intended use(s) for this product.

b. Water.

(1) The source of any water to be used in drilling, grouting, sealing, filter placement, well installation, or equipment washing must be approved by the Contracting Officer prior to arrival of the drilling equipment onsite. Parameters for approval include:

(a) A deep aquifer origin (ideally, greater than 200 feet below ground surface).

(b) Well head upgradient of potential contaminant sources.

(c) Free of survey-related contaminants by virtue of pretesting (sampling and analysis) by the contractor using a laboratory certified by or in the process of being certified by USATHAMA for those contaminants. Pretesting shall be conducted on duplicate samples, each analyzed at a different time, using separate lots.

(d) The water to be non-treated and non-filtered.

(e) The tap to have 24-hour per day, 7-day per week access with plumbing sufficient to allow the filling of a 500 gallon tank in less than 20 minutes.

(f) The use of only one designated tap for access.

(2) Periodic testing of the approved water source may be required when the water is used to clean the sampling equipment after well installation. A detailed discussion of these requirements is provided in the USATHAMA Quality Assurance Program.

(3) Surface water bodies shall not be used, if at all possible.

(4) If a suitable source exists onsite, the contractor shall be directed to that source. If no onsite water is available, the contractor shall locate a potential source and submit the following data, III.A.10.b.(4)(a)-(h), in writing to USATHAMA (see Figure 2) for the Contracting Officer's approval prior to the arrival of any drilling equipment onsite. Allow three calendar weeks from the time of receipt by USATHAMA for request evaluation and recommendation.

(a) Owner/address/telephone number.

(b) Location of tap/address.

(c) Type of source (well, pond, river, etc.). If a well, specify static water level (depth), date measured, well depth, and aquifer description.

(d) Type of treatment and filtration prior to tap (chlorination, fluoridation, softening, etc.).

(e) Time of access (24-hours per day, 5-days per week, etc.).

(f) Cost per gallon charged by Owner/Operator.

(g) Results and dates of all available chemical analyses over past two years. Include the name(s) and address(s) of the analytical laboratory(s)

(h) Results and date(s) of duplicate chemical analysis (see III.A.10.b.(1)(c)) for project contaminants by a laboratory certified by or in the process of being certified by USATHAMA for those contaminants.

(5) The contractor has the responsibility to procure, transport, and store the water required for project needs in a manner to avoid the chemical contamination or degradation of the water once obtained. The contractor is also responsible for any heating, thermal insulation, or agitation of the water to maintain the water as a fluid for its intended uses.

(6) The contractor shall enter the chemical and geotechnical data for the approved water source into the Data Management System.

c. Grout.

(1) Materials. Grout, when used in monitor well construction or well abandonment, shall be composed by weight of 20 parts cement (Portland cement, type II or V) up to 1 part bentonite with a maximum of 8 gallons of approved water per 94 pound bag of cement. Neither additives nor borehole cuttings shall be mixed with the grout. Bentonite shall be added after the required amount of cement is mixed with water.

(2) Equipment. All grout materials shall be combined in an above-ground rigid container or mixer and mechanically (not manually) blended onsite to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout shall be recirculated through the grout pump prior to placement. Grout shall be placed using a grout pump and tremie. The grout pump for recirculation and placement shall be a commercially available product specifically manufactured to pump cement grouts. The tremie pipe shall be of rigid, not flexible, construction. Drill rods, rigid polyvinyl chloride (PVC) or metal pipes are acceptable tremies. Hoses and flexible PVC are unacceptable. Grout placement, via gravity and the grout head, using an elevated grout tank is expressly prohibited.

(3) Grout shall be placed in the monitor wells as follows:

(a) When a bentonite seal is used as shown in Figures 5 or 6:

(i) Prior to exposing any portion of the borehole above the seal by the removal of any drill casing (to include hollow-stem augers), the annulus between the well casing and drill casing shall be filled with grout.

(ii) The grout shall be placed from within a rigid tremie pipe, located just over the top of the seal.

(iii) The grout shall be pumped through this pipe to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The grout shall not penetrate the well screen or granular filter pack. Disturbance of the bentonite seal should be minimal.

(iv) The drill casing shall then be removed and more grout immediately added to compensate for settlement.

(v) If drill casing (to include hollow-stem auger) was not used, proceed with grouting to ground surface in one, continuous operation.

(vi) After 24 hours, the contractor shall check the site for grout settlement and that day add more grout to fill any settlement depression.

(vii) Repeat this process until firm grout remains at ground surface.

(viii) Incremental quantities of grout added in this manner shall be recorded as added and the data submitted to the Contracting Officer through USATHAMA on the well diagram (or addendum).

(b) When no bentonite seal is used (unusual occurrence requiring specific Contracting Officer approval):

(i) The contractor shall mix, place, monitor, and report grout usage as described above: III.A.10.c.(1) to (3)(a)(viii), but position the rigid tremie pipe just above the granular filter pack.

(ii) Place the grout so as to avoid grout penetration into the underlying granular filter pack and screen.

(4) If field conditions permit, the contractor may incrementally place grout and remove drill casing so as to constantly maintain 10 feet of grout (minimally) within the casing yet to be removed from the ground. Using this method requires at least 20 feet of grout to be within the casing before removing 10 feet of casing.

(5) For grout placement at depths less than ten feet in a DRY hole, the grout may be poured in place from ground surface.

d. Granular Filter Pack. For this discussion, refer to section III.C.5.

e. Well Screens, Casings, and Fittings. For a discussion of these materials, see section III.C.2.

f. Well Caps and Centralizers. These items are discussed in sections III.C.3. and 4, respectively.

g. Well Protection. Elements of well protection are covered in section III.C.8.

h. Tracers, dyes, or other substances shall not be used or otherwise introduced into borings, wells, grout, backfill, groundwater, or surface water unless specifically required by contract.

i. Summarize the usage of these and any other drilling/well construction materials which potentially could have a bearing on subsequent interpretation of the analytical results. Include this summary within the geotechnical report. An example summary is provided at Table 1.

11. Abandonment. Abandonment is that procedure by which any boring or well is permanently closed. Abandonment procedures shall preclude any current or subsequent discharges from entering the abandoned boring or well and thereby terminate access to the subsurface environment.

a. The abandonment of any borings or wells not scheduled for abandonment per contract, must be approved by the Contracting Officer prior to any casing removal, sealing, or backfilling. Abandonment requests shall be submitted telephonically through USATHAMA to the Contracting Officer with the following data, III.A.11.a.(1)-(3), plus recommendation. Allow four consecutive hours from the time of receipt by USATHAMA for request evaluation and decision. Frequently, resolution is made within minutes. Infrequent circumstances may preclude a four-hour resolution. A written followup memorandum shall be submitted by the contractor within five working days of the telephonic request. This document shall be forwarded through USATHAMA to the Contracting Officer and contain the following data:

(1) Designation of well/bore in question.

(2) Current status (depth, contents of hole, stratigraphy, water level, etc.).

(3) Reason for abandonment.

(4) Action taken, to include any replacement boring or well.

b. Each boring or well to be abandoned shall be sealed by grouting from the bottom of the boring/well to ground surface. This shall be done by placing a grout pipe to the bottom of the boring/well (i.e., to the maximum depth drilled/bottom of well screen) and pumping grout through this pipe until undiluted grout flows from the boring/well at ground surface. Any open or ungrouted portion of the annular space between the well casing and borehole shall be grouted in the same manner also. Grout composition, equipment, and placement procedures are covered in section III.A.10.c.

c. After 24 hours, the contractor shall check the abandoned site for grout settlement. That day, any settlement depression shall be filled with grout and rechecked 24 hours later. This process shall be repeated until firm grout remains at ground surface.

d. Normally an abandoned well shall be grouted with the well screen and casing in place. However, a lack of data concerning well construction or other factors may dictate the removal of the well materials and a partial or total hole redrilling prior to sealing the well site.

e. For each abandoned boring/well, a record shall be prepared to include the following, III.A.11.e.(1)-(13), as applicable. Report all depths/heights from ground surface. The original record shall be submitted to USATHAMA within three working days after abandonment is completed.

(1) Boring/well designation.

(2) Location with respect to the replacement boring or well (if any); e.g., 20 feet north and 20 feet west of Well 14.

(3) Open depth prior to grouting and depth to which grout pipe placed. This includes the depth of open hole, open depth to the bottom of the well, and the open depth in the well-borehole annulus.

(4) Casing left in hole by depth, composition, and size.

(5) Copy of the boring log.

(6) Copy of construction diagram for abandoned well.

(7) Drilled and sampled depth prior to decision to abandon site.

(8) Items left in hole by depth, description, and composition.

(9) Description and total quantity of grout used initially.

(10) Description and daily quantities of grout used to compensate for settlement.

(11) Dates of grouting.

(12) Water or mud level (specify) prior to grouting and date measured.

(13) Remaining casing above ground surface: height above ground, size, and composition.

f. Ideally, replacement wells/borings (if any) will be offset at least 20 feet from any abandoned site in a presumed up- or cross-gradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

12. Soil Samples.

a. Unless otherwise specified in the contract, intact soil samples for physical descriptions, retention, and potential physical analyses shall be taken and retained every five feet or at each major change of material, whichever occurs first. The contractor may propose an alternate sampling frequency in his technical plan. These samples shall be representative of their host environment and are to be obtained with driven (e.g., split spoon), pushed (e.g., thin wall), or rotary (e.g., Denison) type samplers. Auger flight or wash samples will not satisfy this requirement.

b. At the detection of any unusual odors off the auger turnings or intact samples, drilling shall cease for an evaluation of their nature and crew safety. After the field crew completes this evaluation and implements any appropriate safety precautions, drilling shall resume. If the odors are judged by the field crew to be contaminant-related, intact samples shall be continuously taken until the odors are no longer detected in the samples. At that time, normal sampling shall resume. Specific procedures shall be detailed in the contractor's proposal and Safety Plan.

c. Representative soil samples from each sampler shall be placed in half- or one-pint glass jars with air-tight, screw-type lids (canning jars). These jars shall be stored in individual compartments in cardboard boxes. A single box shall not contain more than 24 one-pint jars or 48 half-pint jars. For thin wall (shelby) samples, retain a sample from each tube as described above. The remaining portion may be wasted or sealed in the tube, as per testing requirements. Minimum information on each sample container shall include the boring and sample number. No geotechnical data shall appear on the container that is not specified on the boring log. Jars and tubes shall be kept from freezing.

d. Physical soil testing shall be conducted on ten (10) to twenty (20) percent of the soil samples using procedures and equipment described in the current U.S. Army Corps of Engineers Manual, EM 1110-2-1906: Laboratory Soils Testing, or current Annual Book of ASTM Standards, American Society of Testing and Materials, Part 19. Tested samples shall be representative of the range and frequency of soil types encountered. In addition, they shall be obtained from borings that cover the geographic and geologic range within the study area of the host Army installation. The contractor shall select the particular samples. Tests shall include Atterberg Limits, sieve grain size distribution, and assignment of Unified Soil Classification System symbols. Laboratory and summary sheets shall be submitted to the COR within ten working days of final test completion. The contractor shall address any contaminant-related safety precautions for the physical analysis of these samples in his proposal and Safety Plan.

e. Soil samples for chemical analysis taken from borings shall be obtained in a manner to provide intact specimens; using a split spoon or solid barrel sampler, Denison sampler, etc. These samples shall be extracted from their host environment in as near an intact, undisturbed condition as technically practical. Once at the surface, the sampler shall be opened, sample extracted, peeled, and bottled in as short a time as possible. "Peeling" is a process whereby that portion of the sample which was in direct contact with the sampler, as well as the ends of the sample, are removed and discarded. Samples for volatile analysis shall be peeled, bottled, and capped within fifteen (15) seconds from the time of opening the sampler. Additional acquisition, preservation, and handling criteria for the chemical analysis of soils are found in the current Quality Assurance Program.

f. All soil samples, except those for physical and/or chemical analysis and reference shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

13. Rock Core. The preferred method of drilling bedrock is through coring. This method, using a diamond or carbide studded bit, produces a generally intact sample of the bedrock lithology, structure, and physical condition. The use of a gear-bit, tricone, etc., to penetrate bedrock should only be considered for the confirmation of the "top of rock" (where penetration is limited to a few feet), the enlargement of a previously cored hole, or the drilling of highly fractured intervals.

a. The coring of bedrock or any firm stratigraphic unit shall be conducted in a manner to obtain at least 90% intact recovery. The physical character of the bedrock; i.e., fractures, poor cementation, weathering, or solution cavities, may lessen the desired recovery, even with the best of drillers and equipment.

b. While drilling in bedrock, and especially while coring, drilling fluid pressures shall be adjusted to minimize drilling fluid losses and hydraulic fracturing.

c. Rock cores shall be stored in covered wooden boxes in such a manner as to preserve their relative position by depth. Intervals of lost core shall be noted in the core sequence with annotated wooden blocks. Boxes shall be marked inside and out to provide boring number, cored interval, and box number in cases of multiple boxes. The weight of each fully loaded box shall not exceed 75 pounds. No geotechnical data shall appear on or within the box that is not specified on the boring log. As a minimum, the estimated number of boxes required for each boring shall be on hand prior to coring that site.

d. The core within each completed box shall be photographed after the core surface has been cleaned/peeled and wetted. Photos shall be taken using color film (ASA as appropriate), 35mm camera, 55mm (minimum) lens, light meter, with one box per frame. Each photo shall be in sharp focus and contain both a legible scale in feet and tenths of feet (or centimeters) and a USATHAMA-supplied photographic color chart for color comparison. The core shall be oriented so that the top of the core is at the top of the photo. One set of 3 x 5 inch glossy color prints plus all negatives shall be sent to USATHAMA via registered mail within 2 weeks of the last coring. Each photo shall be annotated on the back as to the bore/well designation, box number, and cored depths denoted in the photograph. The photos shall be used to enhance the interpretation of core sketches and corresponding narrative descriptions.

e. All rock core, except that for analysis and reference, shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

14. Drilling in Contaminated Areas. Many borings and wells are drilled in areas that are clean relative to the deeper horizons of interest. However, circumstances do arise which require drilling where the overlying soils or shallow aquifer may be contaminated relative to the underlying environment. This situation requires the placement of, at least, double casing: an outer permanent (or temporary) casing sealed in place and cleaned of all previous drill fluids prior to proceeding into the deeper, "cleaner" environment. These situations shall be addressed by the contractor on a case-by-case basis in the technical plan.

15. Equipment Cleaning. The steam cleaning of all drilling equipment to include rigs, water tanks (inside and out), augers, drill casings, rods, samplers, tools, recirculation tanks, etc., shall be done prior to project site (installation) arrival followed by onsite steam cleaning with approved water (III.A.10.b.) upon site arrival and between boring/well sites. Prior to use onsite, all casings, augers, recirculation and water tanks, etc., shall be devoid both inside and out of any asphaltic, bituminous, or other encrusting or coating materials, grease, grout, soil, etc. Paint, applied by the equipment manufacturer, need not be removed from drilling equipment. To the extent practical, all cleaning shall be performed in an area that is remote from and surficially cross- or downgradient from any site to be sampled.

16. Work Area Restoration, Disposal of Borehole Cuttings and Well Water. All work areas around the wells and/or borings installed as part of this contract shall be restored to a physical condition equivalent to that of preinstallation. This includes cuttings removal or spreading and rut removal. Borehole cuttings, drilling fluids, and water removed from a well during installation, development, aquifer testing, and presample purging shall be disposed of in a manner approved by the Contracting Officer and the host installation. The contractor shall suggest a disposal procedure and location(s) as part of his technical plan.

17. Physical Security.

a. On Post: While physical security measures are present on most Army properties, the contractor has the ultimate responsibility for securing his own equipment. The contractor shall address any special needs to the onsite installation personnel and include these items in his technical plan.

b. Off Post: For any operations off post, the contractor is totally responsible for his own physical security.

B. Borehole Logging. Each boring log shall fully describe the subsurface environment and the procedures used to gain that description.

1. Format. The format of the boring log shall be determined by the contractor. A suggested format is presented in Figure 4.

2. Submittal. Each original boring log shall be submitted directly from the field to the Contracting Officer's designated office within three working days after the boring is completed. In those cases where a monitor well or other instrument is to be inserted into the boring, both the log for that boring and the installation diagram must be submitted within three working days after the instrument is installed.

3. Originals. Only the original boring log (and diagram) shall be submitted from the field to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice.

4. Time of Recording. Logs shall be recorded directly in the field without transcribing from a field book or other document. This technique reduces offsite work hours for the geologist, lessens the chance for errors of manual copying, and allows the completed document to be field-reviewed closer to the time of drilling.

5. Routine Entries. In addition to the data desired by the contractor and uniquely required by contract, the following information shall be routinely entered on the boring log or attached to the log:

a. Depths/heights shall be recorded in feet and fractions thereof (tenths or inches). Metric measurements are acceptable if typically used by the geologist. The DMS does not accept entries in inches.

b. Soil classifications shall be in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487-69).

c. Soil classifications shall be prepared in the field at the time of sampling by the geologist and are subject to change based upon laboratory tests and/or subsequent review. The mere difference between laboratory and field classification is not sufficient to change the field classification. Additional factors to consider before changing a field determination include the expertise of the field geologist and laboratory personnel, representative character of the tested sample, labeling errors, etc. Any changes made after this consideration shall be discussed and incorporated in the project report(s). The contractor shall also initiate any subsequent corrections to the Data Management System.

d. Each soil sample taken (see III.A.12.) shall be fully described on the log. The descriptions of intact samples shall include the following parameters:

PARAMETER	EXAMPLE
Classification	Sandy Clay
Unified Soil Classification Symbol	CL
Secondary Components and Estimated Percentages	Sand: 25% (Fine sand 5%, Coarse sand 20%)
Color (using Munsell Soil or Geological	Gray: 7.5 YR 5.0 (Munsell)

Society of America (GSA) Rock Color Chart), give both narrative and numerical description and note which chart used.	
Plasticity	Low Plasticity
Consistency (cohesive soil)	Stiff
Density (non-cohesive soil)	Loose
Moisture Content. Use relative term. Do not express as a percentage unless a value has been measured.	Dry, moist, wet, etc.
Texture/Fabric/Bedding and Orientation	No apparent bedding: numerous vertical, iron-stained, tight fractures
Grain Angularity	Rounded
Depositional Environment and Formation, if named	Glacial till, Twin Cities Formation

e. In the field, visual numeric estimates shall be made of secondary soil constituents; e.g., "silty sand with 20 percent fines" or "sandy gravel with 40 percent sand." If such terms as "trace," "some," "several," etc., are used, their quantitative meaning is to be defined on each log or within a general legend.

f. When used to supplement other sampling techniques, disturbed samples; e.g., wash samples, cuttings, and auger flight samples, shall be described in terms of the appropriate soil/rock parameters to the extent practical. "Classification" shall be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth.

g. Rock core shall be visually described for the following parameters:

PARAMETER	EXAMPLE
Classification	Limestone, Sandstone, Granite
Lithologic Characteristics	Shaly, Calcareous, Siliceous, Micaceous
Bedding/Banding Characteristics	Laminated, Thin bedded, Massive, Cross bedded, Foliated
Color (using Munsell Soil or GSA Rock Color Chart), give both narrative and numerical description and note which chart was used.	Mod. brown: 5 YR 3/4 GSA

Hardness	Soft, Very hard
Degree of Cementation	Poorly cemented, Well cemented
Texture	Dense, Fine-, Medium-, Coarse-grained, Glassy, Porphyritic, Crystalline
Structure and Orientation	Horizontal bedding, Dipping beds at 30°, Highly fractured, Open vertical joints, Healed 30° faults/ fractures, Slickensides at 45°, Fissile
Degree of Weathering	Unweathered, Badly weathered
Solution or Void Conditions	Solid, Cavernous, Vuggy with partial infilling by clay
Primary and Secondary Permeability, include estimates and rationale	Low primary: Well cemented High secondary: Several open joints
Lost Core, interval and reason for loss	50-51', noncemented sandstone likely

h. For rock core, provide a scaled graphic sketch of the core on or with the log denoting by depth the location, orientation, and nature (natural or coring-induced) of all core breaks. Note also the intervals by depth of all lost core and hydrologically significant details. This sketch shall be prepared at the time of core logging, concurrent with drilling.

i. Record the brand name and amount of any bentonite used for each boring along with the reason for and start (by depth) of this use.

j. The drilling equipment used shall be generally described either on each log or in a general legend. Record such information as rod size, bit type, pump type, rig manufacturer and model.

k. Each log shall record the drilling sequence; e.g.:

(1) Opened hole with 8" auger to 9'.

(2) Set 8" casing to 10'.

(3) Cleaned out and advanced hole with 8" roller bit to 15' (clean water, no water loss).

(4) Drove standard sampler to 16.5'.

(5) Advanced with 8" roller bit to 30', 15 gallon water loss.

(6) Drove standard sampler to 31.5'.

(7) Hole heaved to 20'.

(8) Mixed 25 pounds of ABC bentonite in 100 gallons of water for hole stabilization and advanced with 8" roller bit to 45', etc.

l. Record all special problems and their resolution on the log; e.g., hole squeezing, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casings, etc.

m. The dates for the start and completion of borings shall be recorded on the log along with notation by depth for drill crew shifts and individual days.

n. Each sequential boundary between the various soils and individual lithologies shall be noted on the log by depth. When depths are estimated, the estimated range shall be noted along the boundary.

o. The depth of first encountered free water shall be indicated along with the method of determination; e.g., "37.6' from direct measurement after drilling to 40.0';" or "40.1' from direct measurement in 60' hole when boring left overnight, hole dry at end of previous shift;" or "25.0' based on saturated soil sample while sampling 24-26'." Allow the first encountered water to partially stabilize (5 to 10 minutes) and record this secondary level and time between measurements before proceeding. Also describe any other distinct water level(s) found below the first.

p. The estimated interval by depth for each sample taken, classified, and/or retained shall be noted on the log. For each driven (split spoon), thin wall (shelby), and cored sample, record the length of sampled interval and length of sample recovery. Record the sampler type and size (diameter and length).

q. Record the blow counts, hammer weight, and length of hammer fall for driven samplers. For thin wall samplers, indicate whether the sampler was pushed or driven. Blow counts shall be recorded in half foot increments when standard (1 3/8" ID by 2" OD) samplers are used. For penetration less than a half foot, annotate the count with the distance over which the count was taken.

r. When drilling fluid is used, quantitatively record fluid losses and/or gains and the interval over which they occur. Adjust fluid losses for spillage and intentional wasting (e.g., recirculation tank cleaning) to more accurately estimate the amount of fluid lost to the subsurface environment.

s. Record the pumping pressures typically used during all rotary drilling operations.

t. Note the total depth of drilling or sampling, whichever is deeper, on the log.

u. Record significant color changes in the drilling fluid return, even when intact soil samples or rock core are being obtained. Include the color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change.

v. Special abbreviations used on a log and/or well diagram shall be defined either in the log/diagram where used, or in a general legend. The general legend, if used, shall be forwarded to USATHAMA with the first log/diagram submittal. An addendum, if required, shall be sent to USATHAMA with the last log/diagram.

C. Well Installation. In the Geotechnical Requirements, the term "monitor well" is used in a generic sense to include observation wells and piezometers. Observation wells differ from piezometers in the length of the open or screened section of the well and location of the well seal (usually bentonite) in relation to the potentiometric or phreatic surface of the aquifer being measured (see Figure 10). Each monitor well is intended for use as a mechanism through which to obtain a representative sample of groundwater and measure the potentiometric surface seen by that well. The installation of either well type is covered by these Requirements. These Requirements are also applicable to other types of hydrogeologic instrumentation; e.g., lysimeters and well points (see Figure 10). The criteria for these and other special instrumentation will be discussed in the specific RFP/RFQ, contract, task, and/or amendment. Any questions regarding these items should be addressed to the COR.

1. Beginning Well Installation.

a. The installation of each monitor well shall begin within 12 consecutive hours of boring completion for holes uncased or partially cased with temporary drill casing. Installation shall begin within 48 consecutive hours in holes fully cased with temporary drill casing. Once installation has begun, no breaks in the installation process shall be made until the well has been grouted and drill casing removed. Anticipated exceptions shall be requested in writing by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow three working days from the time of receipt by USATHAMA for request evaluation and recommendation.. Data to include in this request are:

(1) Well(s) in question.

(2) Circumstances.

(3) Recommendation and alternatives.

b. In cases of unscheduled delays such as personal injury, equipment breakdowns, sudden inclement weather; or scheduled delays such as borehole geophysics, no advance approval of delayed well installation is needed. In those cases, resume installation as soon as practical. In cases where a partially cased hole into bedrock is to be partially developed prior to well insertion (III.D.11.), the well installation shall begin within 12 consecutive hours after this initial development.

c. Once begun, well installation shall not be interrupted due to the end of the contractor's/driller's work shift, darkness, weekend, or holiday.

d. The contractor shall ensure that all materials and equipment for drilling and installing a given well are available and onsite prior to drilling that well. The contractor shall have all equipment and materials onsite prior to drilling and installing any well if the total well drilling and installation effort is scheduled to take 14 consecutive days or less. ("Consecutive days" refers to the continuous combination of "working" and "nonworking days;" i.e., "calendar days."). For longer schedules, the contractor shall ensure that the above materials needed for at least 14 consecutive days of operation are onsite prior to well drilling. The balance of materials shall be either on order or in transit prior to well drilling.

2. Screens, Casings, and Fittings.

a. Typically, only polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and/or stainless steel shall be used. All PVC screens, casings, and fittings shall conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage (or American Society for Testing and Materials (ASTM) equivalent) and bear the appropriate rating logo. If a contractor uses a screen and/or casing manufacturer or supplier who removes or does not apply this logo, the contractor shall include in the Technical Plan a written statement from the manufacturer/supplier (and endorsed by the contractor) that the screens and/or casing have been appropriately rated by NSF/ASTM. Specific materials will be specified in the RFP/RFQ or proposed by the contractor in his RFP/RFQ response for the Contracting Officer's approval. All materials shall be as chemically inert with respect to the site environment as technically possible and practical.

b. All well screens shall be commercially fabricated, slotted or continuously wound, and have an inside diameter equal to or greater than the well casing. For PVC and PTFE screens, their schedule/thickness shall be the same as that of the well casing. Stainless steel screens may be used with PVC or PTFE well casing. No fitting shall restrict the inside diameter of the joined casing and/or screen. All screens, casings, and fittings shall be new.

c. All well screens and well casings shall be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed with approved water prior to use. Pipe nomenclature stamped or stenciled directly on the well screen and/or blank casing within and below the bentonite seal shall be removed (via SANDING). Solvents shall NOT be used for marking removal. Washed screens and casings shall be stored in plastic sheeting or kept on racks prior to insertion.

d. Well screens shall be placed no more than three feet above the bottom of the drilled borehole.

e. All screen bottoms shall be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug shall be within 0.5' of the open portion of the screen (see Figures 5 and 6). No solvents or glues shall be permitted for attachment.

f. Silt traps (also called "cellars") shall not be used. A silt trap is a blank length of casing attached to and below the screen. Their use fosters a stagnant environment which could influence analytical results for trace concentrations.

g. Joints within and between the casing and screen shall be compatibly threaded. Thermally welded joints or couplings shall not be used. This prohibition includes threaded or slip joint couplings thermally welded to casing by the manufacturer or in the field. Solvent welded joints may be used only to make casing repairs or to adjust casing height. Any glue or solvent usage shall be described on the log or well diagram. During these repairs or adjustments which require solvent/glue usage, a clean rag should be tightly fit into the intact well casing to catch any glue spillage. This rag shall be attached to a strong twine for ease of rag removal and to preclude rag loss down the well. The rag and twine shall be removed upon repair completion.

h. Gaskets shall not be used on monitor wells.

i. The top of each well installed under these Requirements shall be level such that the difference in elevation between the highest and lowest part of the well casing/riser shall be less than or equal to 0.02'.

3. Caps and Vents. The tops of all well casings shall be telescopically capped with loosely fitting PVC, PTFE, or stainless steel covers. These covers shall be constructed to preclude binding to the well casing due to tightness of fit, unclean surface, or frost and secure enough to preclude debris and insects from entering the well. No vents shall be placed in these caps (or well risers/stickup). Therefore, the caps shall be loose enough to allow pressure equalization between the well and atmosphere.

4. Centralizers. Well centralizers, when used, shall be of PVC, PTFE, or stainless steel and attached to the casing via stainless steel fasteners or strapping. Centralizers shall not be attached to the well screen or to that part of the well casing exposed to the granular filter or bentonite seal.

5. Granular Filter Pack.

a. All granular filters must be approved by the Contracting Officer prior to drilling. A one-pint representative sample of each proposed granular filter pack, accompanied by the data below, III.C.5.a.(1)-(6), shall be submitted by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow eight working hours for evaluation and recommendation once all of the above data are received by USATHAMA. Each sample shall be described, in writing (see Figure 3), in terms of:

(1) Lithology.

(2) Grain size distribution.

(3) Brand name, if any.

(4) Source, both manufacturing company and location of pit or quarry of origin.

(5) Processing method; e.g., pit run, screened and unwashed, screened and washed with water from well/river/pond, etc.

(6) Slot size of intended screen.

b. Granular filter packs shall be chemically and texturally clean (as seen through a 10X hand lens), inert, siliceous, and of appropriate size for the well screen and host environment.

c. The filter pack shall extend above the top of the screen by at least five feet, unless otherwise specified in the statement of work.

d. The final depth to the top of the granular filter shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed filter.

6. Bentonite Seals.

a. Bentonite seals shall be composed of commercially available pellets. Pellet seals shall be a minimum of five feet thick as measured immediately after placement, without allowance for swelling.

b. Slurry seals shall be used only as a last resort, as when the seal location is too far below water to allow for pellet or containerized-bentonite placement or within a narrow well-borehole annulus. Slurry seals shall have a thick, batter-like (high viscosity) consistency with a placement thickness of five feet maximum.

c. In wells designed to monitor bedrock, the top of the bentonite seal shall be located at least three feet below the top of firm bedrock, as may be determined by drilling. "Firm bedrock" refers to that portion of solid or relatively solid, moderately to unweathered bedrock where the frequency of loose and fractured rock is markedly less than in the overlying, highly weathered bedrock. The interval between the top of the bentonite seal and the top of the highly weathered bedrock shall be filled with grout. Figure 6 denotes the seal location.

d. The final depth to the top of the bentonite seal shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed bentonite.

7. Grouting. Grout mix design and placement are detailed in paragraph III.A.10.c.

8. Well Protection.

a. Protective casing shall be installed around each monitor well the same day as initial grout placement around that well. Any annulus formed between the outside of the protective casing and borehole shall be filled to ground surface with grout as part of the grouting procedure. Requests for exceptions in usage, design, and timing of placement will be considered on a case-by-case basis by the Contracting Officer. Request in writing shall be made prior to drilling. Include in the request the well(s) involved, reason for request, cost savings, recommendation, and alternatives. Allow six working days for evaluation and recommendation after the request is received by USATHAMA.

b. All protective casing shall be steam cleaned prior to placement, free of extraneous openings, devoid of any asphaltic, bituminous, encrusting, and/or coating materials (except the black paint or primer applied by the manufacturer).

c. Minimum elements of protection design include:

(1) A 5-foot minimum length of new, black iron/steel pipe extending about 2.5 feet above ground surface and set in grout (see Figures 5, 6 and 7).

(2) An 8" protector pipe for 5" wells.

(3) A 6" protector pipe for 4" wells.

(4) A 5" protector pipe for 3" wells.

(5) A 4" protector pipe for 2" wells.

(6) A hinged cover or loose fitting telescoping cap to keep direct precipitation and cover runoff out of the casing.

(7) All protective casing covers/caps secured to the casing by means of a padlock from the date of protective casing installation.

(8) All padlocks at a given site (Army installation) opened by the same key. The contractor shall provide two of these keys to a Contracting Officer's designated representative at the installation and two keys to USATHAMA upon the conclusion of well placement.

(9) No more than .2' from the top of protective casing to the top of well casing. This, or a smaller spacing, is critical for subsequent water level determination via acoustical equipment.

(10) The outside only of the protective casing, hinges (if present), and covers/caps painted orange with a paint brush (not aerosol can). Painting required to be completed and dry prior to initially sampling that well. Any color deviations will be conveyed to the contractor by the COR.

(11) The painting of the well designation on the outside of the protective casing, using white paint and a brush. The identification shall be done after the casing is painted as described above. Painting required to be completed and dry prior to initially sampling that well.

(12) The erection of four steel pickets, each radially located 4 feet from each well, placed 2 to 3 feet below ground surface, having 3 feet minimally above ground surface with flagging in areas of high vegetation (see Figure 7). The pickets shall be painted orange, using a brush. Installation and painting shall be completed (and dry) prior to sampling the well.

(13) The above pickets (III.C.8.c.(12)) shall be supplemented with three-strand barbed wire in livestock grazing areas. Installation required prior to sampling.

(14) The placement of an internal mortar collar within the well-protective casing annulus from ground surface to 1/2 foot above ground surface with a 1/4" diameter hole (drainage port) in the protective casing centered 1/8" above this level (see Figures 5 and 6). The mortar mix shall be (by weight) 1 part cement to 2 parts sand (the granular filter used around the well screen), with minimal water for placement. Placement required at least 48 consecutive hours prior to well development.

(15) The application of an approximately .5' thick coarse gravel (3/4" to 3" particle size) blanket extending 4' radially from the protective casing (see Figure 8 for layout and dimensions). Application required prior to development.

(16) Unique specifications for flood protection, if applicable, will be covered on a case-by-case basis.

9. Drilling Fluid Removal. When a borehole, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the borehole fluid should be removed or displaced with approved water (section III.A.10.b.). This removal is intended to remove or dilute the thick fluid and thus allow the proper placement of casing, screen, granular filter, and seal. Fluid losses in this operation shall be initially recorded on the well diagram or boring log and later on the well development record (also see III.D.6., 11., and 14.). Any fluid removal prior to well placement is contingent upon the driller's and the geologist's evaluation of hole stability long enough for the desired well and seal placement.

10. Drilling Fluid Losses in Bedrock. For an option to remove drilling water from bedrock prior to well insertion, see paragraph III.D.11.

11. Schematic Well Construction. Figures 5 and 6 depict schematic well construction. Specific contract requirements described in the statement of work may alter some of the components and/or values shown.

12. Well Construction Diagrams.

a. Each installed well shall be depicted in a well diagram. This diagram shall be attached to the bore log for that installation and shall graphically denote, by depth from ground surface (unless otherwise specified):

(1) The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and boring diameter(s).

(2) Screen location.

(3) Joint locations.

(4) Granular filter pack.

(5) Seal.

(6) Grout.

(7) Cave-in.

(8) Centralizers.

(9) Height of riser without cap/plug above ground surface (stickup).

(10) Protective casing detail.

(a) Height of protective casing without cap/cover (above ground surface).

(b) Base of protective casing.

(c) Drainage port location and size.

(d) Internal mortar collar location.

(e) Gravel blanket height and extent.

(f) Picket configuration.

b. Describe on the diagram or on an attachment thereto:

(1) The actual quantity and composition of the grout, seals, and granular filter pack used for each well.

(2) The screen slot size (in inches), slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer.

(3) The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing.

(4) The joint design and composition.

(5) Centralizer design and composition.

(6) Protective casing composition and nominal inside diameter.

(7) The use of solvents, glues, and cleaners to include manufacturer and type (specification).

(8) Special problems and their resolutions; e.g., grout in wells, lost casing and/or screens, bridging, etc.

(9) Dates for the start and completion of well installation.

c. Each diagram shall be attached to the boring log and submitted from the field to the Contracting Officer's designated office within three working days after well installation. Do not delay this submission until all elements of well protection have been installed. Submit a supplemental diagram for well protection elements to the same designated office within three working days after all elements of well protection are installed.

d. Only the original well diagram and log shall be submitted to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice. A legible copy of the well diagram may be used as a base for the supplemental protection diagram.

e. For abbreviations in the diagrams, see section III.B.5.v.

D. Well Development and Presample Purging.

1. Development: Definition and Purpose. As used herein, "well development" is that process by which one restores the aquifer's hydraulic conductivity and removes well drilling fluids, solids, and other mobile particulates from within and adjacent the newly installed well. "Development" can also refer to that process whereby one removes sediment or other built-up materials from a "clogged," older well. The resulting inflow should be as physically and chemically representative of the host aquifer as the following procedures allow for a newly installed well.

2. Timing and Record Submittal. The development of monitor wells shall be initiated not sooner than 48 consecutive hours after nor longer than 7 calendar days beyond internal mortar collar placement. The record of well development (see section III.D.14.) shall be submitted to the COR within three working days after development.

3. Pump and Bailer Usage. Development shall be accomplished with a pump and may be supplemented with a bottom discharge/filling bailer (for sediment removal) and surge block. A bottom discharge/filling bailer may be used in lieu of a pump in 2-inch wells. Bailers shall not be left inside the wells after development is completed.

4. Development Criteria. Development shall proceed in the manner described herein and continue until all the following are met:

a. The well water is clear to the unaided eye.

b. The sediment thickness remaining within the well is less than 1% of the screen length.

c. The conditions of paragraph III.D.5. (below) are met.

5. Volumetric Removal. In addition to minimally removing five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity), the following apply:

a. For those wells where the boring was made by the use of cable tool, auger, or air rotary methods and without the use of drilling fluid (mud and/or water), only the five volumes plus five times any water used in granular filter pack placement need be minimally removed. Should recharge be so slow that the required volume cannot be removed in 48 consecutive hours, the water remains discolored, or excess sediment remains after the five volume removal; contact the Contracting Officer's designated office for guidance.

b. For those wells where the boring was made or enlarged (totally or partially) with the use of drilling fluid (mud and/or water), remove five times the measured amount of total fluids lost while drilling plus five times the combined amount of standing water,annular water, and that used in filter pack placement as above. The same procedures apply here as above with respect to slow recharge, discoloration, and sediment thickness.

c. See sections III.C.9., III.D.6., and III.D.11. for optional procedures and the requirements if these options are used.

6. Water Additions and Wells with Thick Fluids. Water shall not be added to a well as part of development once the initial seal is placed. However, when a bore, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the contractor should purge or dilute this fluid with clean water from the approved source (also see III.C.9.). A record of purging fluid losses shall be made on both the log or diagram and well development record (III.D.14.). Five times the volume of this loss shall be added to the other volumetric removal requirements for well development.

7. Agents and Additives. No dispersing agents, acids, disinfectants, or other additives shall be used during development or at any other time introduced to the well.

8. Development-Sampling Break. Well development shall be completed at least fourteen consecutive days before well sampling.

9. Pump/Bailer Movement. During development, water shall be removed throughout the entire water column by periodically lowering and raising the pump intake (or bailer stopping point).

10. Development Water Sample. For each well, a one-pint sample of the last water to be removed during development shall be obtained and given to the installation environmental coordinator (or USATHAMA-specified individual) for disposition, within three working days of developing that well. No preservation of these samples is required. However, the contractor shall ensure that these samples do not freeze while in his possession.

11. Partial Bedrock Development. If large drilling water losses occur in bedrock and if the hole is cased to bedrock, the contractor may remove at least five times this volumetric loss prior to well insertion. The intent here is to allow the placement of a larger pump in the borehole than otherwise possible in the well casing thereby reducing the development time and removing the lost water closer to the time of loss. Development of the completed well could then be reduced by a volume equal to that which was removed as above. However, the requirement shall still remain to remove at the time of well development at least five times the combination of standing water, water in the saturated annulus, plus that which was added during filter pack placement. Record the amount removed per above on the well diagram and in the well development record (III.D.14.).

12. Well Washing. Part of well development shall be the washing of the entire well cap and the interior of the well casing above the water table using only water from that well. The result of this operation shall be a well casing free of extraneous materials (grout, bentonite, sand, etc.) inside the riser, well cap, and blank casing between the top of the well casing and the water table. This washing shall be conducted before and/or during development, not after development.

13. Problems. If problems are encountered during development, contact the COR within 24 consecutive hours for guidance.

14. Well Development Record Requirements. The following data shall be recorded as part of development and submitted per section III.D.2.:

a. Well designation.

b. Date(s) of well installation.

c. Date(s) of well development.

d. Static water level from top of well casing before and 24 consecutive hours after development.

e. Quantity of mud/water:

(1) Lost during drilling.

(2) Removed prior to well insertion (III.D.11.).

(3) Lost during thick fluid displacement (III.C.9. and III.D.6.).

(4) Added during granular filter placement.

f. Quantity of fluid in well prior to development.

(1) Standing in well.

(2) Contained in saturated annulus (assume 30% porosity).

g. Field measurement of pH before, twice during, and after development using an electrometric device (EPA 150.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020).

h. Field measurement of specific conductance (electrical conductivity) before, twice during, and after development using a conductivity meter (EPA 120.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4 - 79-020). Obtain conductance and pH readings concurrently.

i. Depth from top of well casing to bottom of well (from diagram).

j. Screen length (from diagram).

k. Depth from top of well casing to top of sediment inside well, before and after development.

l. Physical character of removed water, to include changes during development in clarity, color, particulates, and odor.

m. Type and size/capacity of pump and/or bailer used.

n. Description of surge technique, if used.

o. Height of well casing above ground surface.

p. Typical pumping rate.

q. Estimated recharge rate.

r. Quantity of fluid/water removed and time for removal (present both incremental and total values).

15. Presample Purging: Definition and Purpose. "Presample purging" refers to the removal of water from a well IMMEDIATELY prior to sample acquisition. This ensures a fresh and representative sample for analysis. In general, the USATHAMA Installation Restoration Program, Quality Assurance Program requires five times the calculated volume of water in the well and saturated well annulus to be removed immediately prior to sampling. Therefore, any water removed from a well as part of "development" shall not be counted toward the volumetric removal required in presample purging. Additional presample purging requirements are discussed in the current USATHAMA Quality Assurance Program.

E. Water Levels.

1. Measurement and Datum. The depth to groundwater shall be measured from the highest point on the rim of the well casing or riser (not protective casing). This same point on the well casing shall be surveyed for vertical control (see III.I.2). The depths to groundwater shall be converted to elevations for report usage. To enter the depths into the Data Management System, the well riser height above ground surface (stickup) must be subtracted from the above measured depth.

2. Contour Requirements. For contouring and reporting purposes, at least one complete set of static water level measurements shall be made over a single, consecutive 10-hour period for all wells (newly installed and specified) in the project. Static levels in borings not converted to wells shall be included if practical and technically appropriate.

3. Ground and Surface Water. Determine and report the elevations, to within $\pm$ 0.1 foot, of any streams, lakes, or open water bodies (natural and man-made), within 300 feet of monitor wells used in this contract or task. Use these data for the refinement of the groundwater contours in the vicinity of surface water if a hydrological connection is believed to exist.

F. Well and Boring Acceptance Criteria.

III.F.

1. Well Criteria. Wells must be acceptable to the Contracting Officer. Well acceptance shall be on a case-by-case basis. The following criteria shall be used along with individual circumstances in the evaluation process.

a. The well and material placement shall meet the construction and placement specifications of these <u>Geotechnical Requirements</u> as modified, if at all, by the contract/task.

b. Wells/boreholes shall not contain portions of drill casing or augers unless they are contractually required as permanent casing.

c. All well casing and screen materials shall be free of any unsecured couplings, ruptures or other physical breakage/defects before and after installation.

d. The annular material (filter pack, bentonite, and grout) surrounding each installed well shall form a continuous and uniform structure, free of any fractures or cracks.

e. Any casing or screen deformation or bending shall be minimal to the point of allowing the insertion and retrieval of the pump and/or bailer optimally designed for that size casing (e.g., a 4-inch pump in a 4-inch schedule 40, PVC casing is optimal; a 2-inch pump in a 4-inch casing is not optimal).

f. All joints shall be constructed to provide a straight, nonconstricting, and water-tight fit.

g. Installed wells (fully or partially cased) shall be free of extraneous objects or materials (e.g., tools, pumps, bailers, packers, excessive sediment thickness, grout, etc.).

h. For those monitor wells where the screen depth was determined by the contractor, the well shall have sufficient free water at the time of water level measurement (III.E.2.) to obtain a representative groundwater level for that site. These same wells shall have sufficient free water, at the time of initial sampling, which is representative of the desired portion of the aquifer for the intended chemical analysis.

i. Data for all required geotechnical files in the Data Management System shall be acceptably entered and verified by the contractor.

2. Abandoned Borings and Wells. Borings not completed as wells shall be abandoned per section III.A.11. and the data therefrom acceptably entered and verified by the contractor into the Data Management System.

3. Well and Boring Rejection. Wells and borings not meeting these criteria are subject to rejection by the Contracting Officer.

G. Geophysics. The use of geophysical techniques, if required, will be specified in the RFP/RFQ. In the absence of this specification, the contractor should consider these techniques for site-specific applicability to enhance the technical acuity and cost-effectiveness of his efforts. Special applications may be useful in unexploded ordnance detection, disturbed area delineation, contaminant detection, depth to bedrock, buried drum detection, borehole and well logging, etc. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), resolution, and accuracy. The contractor shall also address the safety aspects of geophysical applications in his proposal and Safety Plan, especially for those areas where induced electrical currents or seismic waves could detonate unexploded ordnance or other explosive materials. If geophysical techniques are used, the same topics shall be addressed in the geotechnical report.

H. Vadose Zone Monitoring. Data acquisition from the vadose (unsaturated) zone shall be addressed on a case-by-case basis. The use of lysimeters in a silica flour matrix, soil-gas monitors, and analysis of bulk soil samples are mechanisms which may be employed by the contractor. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), and analytical variances from the current USATHAMA Quality Assurance Program.

I. Topographic Survey.

1. Horizontal Control. Each boring and/or well installed under this contract shall be topographically surveyed by a licensed surveyor to determine its map coordinates using a Universal Transverse Mercator (UTM) or State Planar grid to within ± 3' (± 1 meter).

2. Vertical Control. Elevations for the natural ground surface (not the top of the coarse gravel blanket) and the highest point on the rim of the uncapped well casing (not protective casing) for each bore/well site shall be surveyed by a licensed surveyor to within ± 0.05' (± 1.5 centimeters) using the National Geodetic Vertical Datum of 1929.

3. Field Data. The topographic survey shall be completed as near to the time of last well completion as possible, but no longer than five weeks after well installation. Survey field data (as corrected), to include loop closure for survey accuracy, shall be included within the geotechnical or final report. Closure shall be within the horizontal and vertical limits given above. These data shall clearly list the coordinates (and system) and elevation (ground surface, top of well, and protective casings) as appropriate, for all borings, wells, and reference marks. All permanent and semipermanent reference marks used for horizontal and vertical control (bench marks, caps, plates, chiseled cuts, rail spikes, etc.) shall be described in terms of their name, character, and physical location.

J. Data Management System.

1. Usage of the Data Management System (DMS) is a means to record and monitor contract performance; store, compare, and evaluate data; and provide cost-efficient, report quality tables and graphics. The System is thereby useful to both administrative and technical users.

2. The geotechnical data acceptably entered in the computer shall be regarded as having the technically best quality for evaluation and decision making. Any deviation from the field data shall be specified and discussed by the contractor in the geotechnical report (see III.B.5.c. and III.K.3.j.(6)).

3. To computerize all of the field-generated data would be neither useful nor cost-effective for most projects. Therefore, only those items specified in III.J.6. shall be acceptably entered on a routine basis by the contractor for each contract or task. These data shall be entered for new borings, wells, and other sampling points; e.g., existing wells, surface water, sediment, and soils, specified in the contract or task. If the contractor wishes to use additional geotechnical files or entries, the contractor shall first receive COR's approval.

4. The items selected for DMS entry shall be entered in one or more of four geotechnical files:

a. Map File (GMA).

b. Field Drilling File (GFD).

c. Well Construction File (GWC).

d. Groundwater Stabilized File (GGS).

5. These files, and others, along with data entry procedures are fully described in Sections 3 and 4 of the Installation Restoration Data Management User's Guide. Additional geotechnical files are available but are not routinely used. The contract or task will specify additional files to be completed, if required.

6. The following lists, arranged by file, denote those items which the contractor shall acceptably enter and verify. Consult the DMS User's Guide for specific coding.

a. Map File (GMA).

(1) Installation.

(2) Site Type.

(3) Site Identification/Site Number.

(4) Coordinates and Coordinate System.

(5) Ground Surface Elevation.

(6) Source and Accuracy of Mapping Data.

(7) Aquifer.

(8) Pointer Information (cross reference for each boring and associated well(s)).

(9) Source of Data (company and individual).

b. Field Drilling File (GFD).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to First Encountered Water.

(5) Depth to Bedrock.

(6) Depth to Deepest Part of Boring.

(7) Unified Soil Classification System Symbol (expanded for bedrock lithologies).

(8) Lithologic Intervals (by depth and thickness).

(9) Source of Data (company and individual).

(10) Dates.

c. Well Construction File (GWC). The abbreviations in parentheses which follow are the "Action Measurements," as explained in the User's Guide.

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Stickup (STKUP).

(5) Bentonite Seal Interval (BSEAL).

(6) Blank Well Casing Interval (CASE).

(7) Well Casing Diameter (CASED).

(8) Length of Overburden Casing (CSEAL).

(9) Overburden Casing Diameter (CASES).

(10) Total Depth of Boring (DPTOT).

(11) Filter Pack Interval (GFILT).

(12) Grout Interval (GROUT).

(13) Screen Interval (SCREN).

(14) Dates.

(15) Source of Data (company and individual).

d. Groundwater Stabilized File (GGS).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to Water (from ground surface).

(5) Date(s) Measured.

(6) Source of Data (company and individual).

7. Figures 11 to 15 are provided as examples of completed DMS coding sheets for each of the above files using the example boring log and well diagram (Figures 4 and 6, respectively). Additional data required for coding but not shown on Figures 4 or 6 follow:

a. Abbreviations:

GP = General AAP
PALEO = Code used for aquifer at General AAP.

b. Field Data:

(1) Surveyed coordinates for boring in UTM system are:

X : 54321 centimeters
and Y : 99876 centimeters.

(2) Surveyed ground surface elevation for boring is 4321 centimeters, using National Geodetic Vertical Datum of 1929.

(3) Well 87-14 is located in the same hole made by boring 87-14.

(4) Cement grout proportioned per these Requirements (cement:bentonite = 20:1).

(5) Well screen: 4" PVC, Schedule 40, .01 inch slot.

(6) Well installed 8 Nov 87.

(7) Water levels recorded by Mr. Smith after development were as follows:

Date	Depth from Top of Riser (ft)
12 Nov 87	9.0

20 Dec 87	9.7
04 Jan 88	11.4

K. Geotechnical Reports.

1. General. Requirements of the geotechnical report are discussed herein along with required guidelines for the technical writing style. When a separate geotechnical report is not required per contract, the elements herein shall be incorporated into the final contract/task report(s).

2. Report Contents. The geotechnical report shall contain as a minimum:

a. Title page.

b. Disclaimer.

c. DD Form 1473.

d. Abstract.

e. Table of Contents.

f. Background.

g. Regional Geology.

h. Site Geology.

i. Methodology.

j. Significant Conclusions.

k. Geotechnical Analysis.

l. Recommendations.

m. References.

n. Bibliography.

o. Appendices.

(1) Boring Logs.

(2) Well Diagrams.

(3) Well Development.

(4) Water Levels.

(5) Special Problems and Resolution.

(6) Aquifer Testing and Hydraulic Parameters.

(7) Geophysical Data.

(8) Vadose Zone Monitoring data.

(9) Physical Analyses.

(10) Topographic Survey Data.

p. Distribution List.

3. Content Details. Details of the above items are listed below:

a. Title Page. The title page contains the following:

(1) Title.

(2) Author(s).

(3) Company (prime contractor).

(4) Report Date.

(5) Report/Contract Number (provided by USATHAMA).

(6) Distribution Statement (statement indicating the agency authorized to release the report, provided by USATHAMA).

(7) Organization(s) for which report was prepared (typically a Department of the Army installation and USATHAMA).

(8) USATHAMA Address.

b. Disclaimer. The following "DISCLAIMER" shall immediately follow the title page:

<u>"DISCLAIMER"</u>

"The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

The use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial products. This report may not be cited for purposes of advertisement."

c. Department of Defense (DD) Form 1473. This form shall be completed by the contractor. The data for blocks 1, 2, 3, 5, and 20 will be furnished by USATHAMA. A blank form is shown in Figure 9.

d. Abstract. The abstract is a summary of purpose, setting, and significant conclusions. This abstract should be more detailed than that given on the DD Form 1473.

e. Table of Contents. This item shall contain:

(1) Major Headings.

(2) Page Numbers.

(3) Figures, Tables, Plates (separately listed).

f. Background. Provide the objective of the geotechnical effort and a discussion of the contractor's corporate involvement within total survey.

g. Regional Geology. Include a discussion of the following topics for adjacent counties and states (as appropriate).

(1) Setting. Include maps and graphics for:

(a) Topography.

(b) Geomorphology.

(c) Physiography.

(d) Drainage.

(2) Stratigraphy. Include a complete, ideal sequence.

(3) Structure and Seismic Activity. Include cross sections.

(4) Hydrology. Include a discussion of surface and groundwater occurrences, drainage area, cross sections, and contour plots of potentiometric surfaces.

h. Site Geology. Discuss site specifics and how the site conforms and/or departs from the regional discussion based upon the knowledge gained from this study.

(1) Setting. Include local aspects of the regional setting.

(2) Stratigraphy. Discuss the sequence encountered.

(3) Structure and Seismic Activity. Include cross sections and local seismic history.

(4) Hydrology. Include hydrostratigraphic cross sections, contour plots, and a discussion of the relationship(s) between surface water and each aquifer encountered.

i. Methodology.

(1) Geotechnical Approach. Discuss literature and field considerations, provide boring and well placement rationale for each drilling site, note drilling locations on a detailed installation map and the largest scale U.S. Geological Survey topographic map depicting the installation.

(2) Drilling techniques. Specify the equipment, water source, procedures, and contractor.

(3) Borehole logging. Describe the procedures and specify the contractor.

(4) Well installation. Describe the materials (casing, screen, bentonite, cement, water, filter pack, etc. (see Table 1), construction procedures, and contractor.

(5) Well development. Specify the equipment, procedures, and contractor.

(6) Geophysical techniques. Provide the purpose, methods and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific), resolution, accuracy, and contractor(s).

(7) Vadose Zone Monitoring. Provide the purpose, particular method(s) and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific) and contractor(s).

(8) Topographic surveying. Specify the equipment, control systems, procedures, and contractor.

(9) Aquifer Tests. Specify the type of tests, literature reference, equipment, general procedure, and contractor.

(10) Physical Analyses. Provide the type of tests, literature references, and contractor.

j. Geotechnical Analysis.

(1) Provide indepth discussions of those geotechnical areas which were significant to the development of the report's conclusions. Describe any uncertainties or extrapolations of data and their relative importance to the conclusions drawn. Provide the data base, references, and actual calculations (in an appendix if over three pages) for quantitative discussions.

(2) Detail the integration of potential contaminant source locations, geologic, hydrologic, and available chemical data. Include how known or estimated groundwater velocities, directions, and chemical quality correspond to known or suspected up-, down-, and cross-gradient contaminant locations. For example, evaluate the occurrence of contaminants at a down-gradient well in terms of most likely up-gradient source, groundwater velocity and direction known or estimated in that area.

(3) Discuss each contaminant site in terms of the geologic, hydrologic, and (when available) chemical data generated by this study. Combine these individual site presentations into a total installation environmental discussion. Relate the installation environmental setting to the regional level. This site to regional development shall be done graphically with narratives to cover key and subtle points.

(4) Present and evaluate the results of any geophysical efforts in terms of design versus actual results, and actual results versus confirmatory/ground truth data; e.g., water levels, chemical analyses, borehole stratigraphy, etc.

(5) Discuss and evaluate the results of any vadose zone monitoring.

(6) Specify and discuss any soil classifications and any other geotechnical data which were changed from the original field descriptions (see III.B.5.c.).

k. Significant Conclusions. Provide summary discussions of those project results which bear upon the intended survey objectives and related areas. Avoid quantitative conclusions based upon qualitative data. Highlight the limitations imposed upon the extrapolation of quantitative conclusions.

l. Recommendations. In addition to any specific recommendations requested within the Statement of Work, the contractor shall recommend those actions (if any) to refine or fill key data gaps and areas of uncertainty relative to the project objective. Additional recommendations should be made for those areas where a change in technique, methodology, or approach could result in a technical or cost benefit in any future efforts at the installation. The COR will specify whether the recommendations shall be included as part of the geotechnical or final report or be provided under a separate cover.

m. References. List by author, title, publication, volume, date, etc., those sources specifically referenced within the geotechnical report.

n. Bibliography. List as above those sources which provided or could provide general project-related data.

o. Appendices. Include data too bulky to be presented within the main body of the report; e.g., extensive tables or figures, or groups of data covering more than three pages. Where these data are in the DMS, they shall be presented in tabular and/or graphic form by the contractor directly from this System. The contractor shall coordinate with the COR to accomplish this requirement.

(1) Boring Logs. Provide legible copies of the "as submitted" field logs, uncorrected by office review and any lab analyses.

(2) Well Diagrams. Provide a detailed graphical presentation for each well with data per contract, to include hole depth, locations of screen, joints, centralizers, top of riser, top of protective casing, cave-in, granular filter pack, bentonite, grout, etc. Include an adjacent staff with appropriate Unified Soil Classification Symbols/rock classification for the entire length of drilled hole. Also graphically detail the protective measures at the well head; protective casing, pickets, caps, locks, etc. Key these sketches to both ground surface (depths below/heights above) and elevation (National Geodetic Vertical Datum of 1929).

(3) Well Development. Provide contractual data in tabular form.

(4) Water Levels. Provide, in tabular form, a listing of water levels (depths and elevations) for each well to include: well number, ground surface elevation, riser height above ground surface (stickup), riser elevation, first encountered water, initial 24-hour level after development, and subsequent static levels measured during the course of the contract. Each level must be annotated as to date of measurement and point from which measured. At least one complete set of static level measurements must be made and included for all project wells over a ten-hour period.

(5) Special Problems and Resolution. Discuss any special geotechnical problems and their resolution. This topic may be addressed in a separate letter to the COR.

(6) Aquifer Testing and Hydraulic Parameters. For the procedures and parameters required by contract, provide a detailed discussion of methodology used, assumptions made, and accuracy measured. Discuss how field conditions varied from those assumed in the method used. Evaluate the values measured against values reported in similar environments and against the setting and manner in which the values of this study were measured. Include references, field data, graphs of field data (e.g., time vs. drawdown plots), sample calculations for each parameter, and a graphical sketch of the relation between field and equation parameters. Present results in tabular form.

(7) Geophysical Data. Provide the data obtained during the study and any lengthy discussions better suited for an Appendix rather than in the main text.

(8) Vadose Zone Monitoring. Provide the data from any monitoring and any detailed discussions more appropriate for Appendices.

(9) Physical Analyses. Provide the references for all tests run. Include the method and procedures for any permeameter tests. Present the results in tabular form. Also, include grain-size graphs. Provide a discussion of these analyses with respect to permeability, both alone and as a comparison with aquifer test results.

(10) Topographic Survey Data. Provide a corrected, legible copy of the field topographic data; and in tabular form, the corrected coordinates and elevation of each surveyed and key feature, including, bores and wells, bench marks, key control points, etc. For each well, include the elevations of the top of the well riser, protective casing, and ground surface. See paragraph III.I. for more guidance. Provide a statement of closure, indicating the amount of error (in feet) to be expected for each set of coordinates and elevations.

p. Distribution List. This list will be provided by the Contracting Officer.

4. Technical Writing Style.

a. Be quantitative. Use single, numerical values or ranges to convey magnitude, size, extent, etc. When ranges are used, denote the most probable value or a narrower, subrange of most probable occurrence. If qualitative terms must be used, define them within a numerical range.

b. Express confidence. Discuss the degree of confidence within the quantitative values generated. This confidence may be a function of field or lab conditions, technique, equipment, practice vs. theory, experience, personal bias, etc. Quantify the degree of confidence for key parameters such as elevations, velocities, permeabilities, porosities, gradients, etc. This shall be done through the use of (a) ranges with a most probable value, or (b) a single number with a plus-or-minus value attached.

c. For each point raised, provide a complete discussion. Do not leave the reader with unanswered questions which could have been naturally anticipated.

d. For maps, cross sections, boring staffs, well sketches, contour plots, etc., provide graphic scales (both vertical and horizontal) and a north arrow, as appropriate. Orient maps, contour plots, etc., with north toward the top of the page/sheet and orient the legend in the same manner as the map. Orient each graphic and its legend so that both can be easily read without rotating the graphic. Expand the graphics to cover the full paper size. Make all graphics fully and easily legible. Avoid any color coding on graphics. Provide vertical scales on both sides of each cross section and a horizontal scale along the base.

e. Adjust groundwater contours for topography (hills and valleys), streams (discharging, recharging), impermeable bedrock, and other obvious expressions of or alterations to the plotted groundwater contours.

f. Number all pages and denote those intentionally left blank.

g. Make sure separate graphics containing similar data agree. Make sure the field data, as corrected, agree with the graphical, tabular, and narrative presentations. Specify and discuss any changes made to the field data.

h. Address the four dimensional aspects of groundwater flow (X, Y, Z components and time) for each aquifer. The use of flow nets to supplement groundwater profiles and contours is desired.

i. Based on presurvey and survey data, provide hydrogeologic cross sections for the installation. These sections should include boring staffs with Unified Soil (and rock) Classification Symbols, summary well diagrams (with screen and seal locations noted), estimated stratigraphic correlation between borings, and estimated groundwater profiling.

j. <u>USE TABULAR FORMATS WHEREVER PRACTICAL</u>.

k. Provide literature/source credits for all data used or modified by the contractor. Credits shall appear in the text, on graphics, and in the list of references.

III.

L. Summary Lists.

1. Procedural and Material Summary. Table 2 denotes those geotechnical procedures and materials requiring specific USATHAMA-COR approval prior to their usage and the expected times for geotechnical evaluation and recommendations.

2. Document Submission Summary. In addition to those items to be submitted for approval per III.L.1., various documents and items discussed in these Geotechnical Requirements are to be submitted to the COR designated office (typically USATHAMA) after a particular action is completed. These materials and their submission times are summarized in Table 3.

M. FIGURES

BENTONITE APPROVAL REQUEST

Army Installation for Intended Use:

1. Bentonite Brand Name:

2. Bentonite Manufacturer:

3. Manufacturer's Address and Telephone Number:

4. Product Description (from package label or attach brochure):

5. Intended Use:

SUBMITTED BY:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer/Date:	A	D
Project Geologist/Date:	A	D

BENTONITE APPROVAL REQUEST
FIGURE 1

WATER APPROVAL REQUEST

Army Installation for Intended Use:

1. Water source:

   Owner:

   Address:

   Telephone Number:

2. Water tap location:

   Operator:

   Address:

3. Type of source:

   Aquifer:

   Well depth:

   Static water level from ground surface:

   Date measured:

4. Type of treatment prior to tap:

5. Type of access:

6. Cost per gallon charged by Owner/Operator:

WATER APPROVAL REQUEST
FIGURE 2

Page 1 of 2

7. Attach results and dates of chemical analyses for past two years. Include name(s) and address(s) of analytical laboratory(s).

8. Attach results and dates of duplicate chemical analyses for project analytes by the laboratory certified by, or in the process of being certified by, USATHAMA for those analytes.

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer:	A	D
Project Geologist/Date:	A	D
Project Chemist/Date:	A	D

WATER APPROVAL REQUEST

FIGURE 2

Page 2 of 2

GRANULAR FILTER PACK APPROVAL REQUEST

Army Installation for Intended Use:

1. Filter Material Brand Name:

2. Lithology:

3. Grain Size Distribution:

4. Source:

   Company that made product:

   Location of pit/quarry of origin:

5. Processing Method:

6. Slot Size of Intended Screen:

Submitted by:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer Name/Date:	A	D
Project Geologist Name/Date:	A	D

GRANULAR FILTER PACK APPROVAL REQUEST

FIGURE 3

BORING LOG GENERAL DATA

Project: GENERAL AAP Boring: 87-14 Page: 1 of 3

Driller & Company: JACK JONES OF ACME CO

Geologist/Logger & Company: J. SMITH OF ACE CO Signature: J Smith

Date Boring Started: 7 NOV 87 Completed: 8 NOV 87

Water Levels (from Ground Surface) Drilling Rig: ABC 20

First Encountered: 7.0' Date: 8 NOV 87

While Drilling: 7.0 Date: 8 NOV 87

At Boring Completion: NOT MEAS. Date: 8 NOV 87

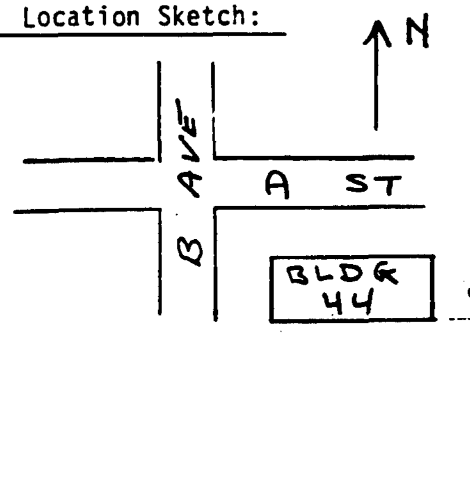
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
1987	Start	End	Start	End		Start	End	Start	End
7 NOV	1500	1700	0	5					
8 NOV	0800	1700	5	18.5					

Abbreviations:

Abbr	Meaning
3x3½ / 2x2½	ID & OD OF SPL BBL SAMPLER
STD	1 3/8 x 2 STANDARD SAMPLER
R	RECOVERY
C/B	CORING INDUCED BREAK
NB	NATURAL BREAK
LC	LOST CORE
3x	3x3½ SAMPLER
2x	2x2½ SAMPLER

Location Sketch:



BORING LOG FORMAT

FIGURE 4

Project: GENERAL AAP	Boring: 87-14	Page: 2 of 3

Depth/ Elevation (FT)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE	0		
0	OL	ORG CLAY, SANDY DK RED BRN 5YR 3/4 (MUNSELL) V MOIST, L PLAST ROOTMAT, TOPSOIL	S#1	3x3½ 3	NOTES: 1- ALL SAMPLERS DRIVEN BY 140LB HAMMER, FALLING 30"
.8 / 1	SM	TRANSITIONAL .8 - 1.5 SILTY SAND 20% FINES	.8	2 R1.5	2- ALL DEPTHS & RECOVERIES IN FT
2		F-M SAND < 60% F, 20% M MOIST, LOOSE YEL BRN 10YR 5/4	1.5 S#2	2x2½ 4	3- DEPTHS FROM GROUND SURFACE NOTE 0' 1- DROVE 3X TO 1.5' 2- DROVE 2X TO 3.5' 3- DROVE STD TO 5'
3		FAINTLY BEDDED FLAT LYING & X-BEDDED < 5% SILTY CLAY (CL) LAMINAE	3.0	6 R1.5	4- SET HSA W/ PLUG TO 5', PULLED PLUG (HSA: 3¼" ID, 7" OD)
4		FLUVIAL SHARP	3.5 S#3 4.6	STD 2 4	
.6 / 5	SP	SAND < 5% FINES	5.0	5 R1.5	END 7 NOV 87
		F-C SAND { 60% C, 10% M, 25% F	S#4	3X 10	START 8 NOV NOTE 5' 1- HOLE DRY + OPEN TO 5'
6		V MOIST - SAT NO APPARENT BEDDING LOOSE LT RED BRN 5YR 6/4	6.0 6.5	5 R1.0	2- DROVE 3X TO 6.5' 3- DROVE 2X TO 8.5'
7		V MOIST SAT FLUVIAL	S#5 7.5	2X 8	4- FREE WATER ON SAMPLER & IN SAMPLE 5- MEAS. WATER AT 7.0 W/ ELEC TAPE. AFTER 5 MIN, STILL AT 7.0
8		SHARP		10	6. DROVE STD TO 10'
	GP	SANDY GRAVEL 20% F-C SAND 80% F GRAVEL	8.5	R1.0	7. SET HSA W/ PLUG TO 10', PULL PLUG
9		LT RED BRN 5YR 6/4 MED DENSE SAT, NO APP BED FLUVIAL	S#6	STD 2 4	
10			9.8	8	

BORING LOG FORMAT

FIGURE 4

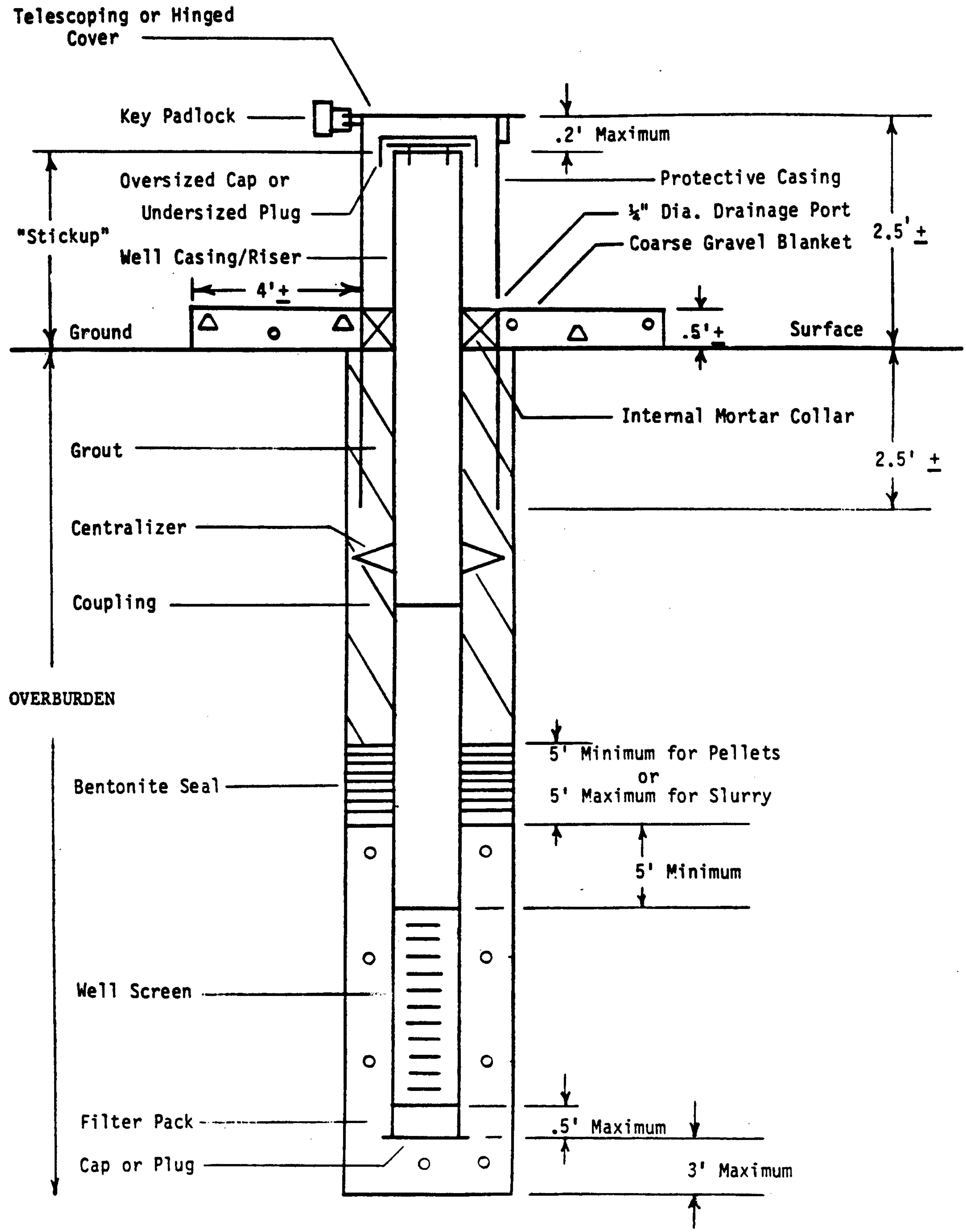
Project: GENERAL AAP | Boring: 87-14 | Page: 3 of 3

(FT) Depth/ Elevation	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
10	GP	SANDY GRAVEL (CONT'D)	10 S#7 10.6	10 3X 100 R.5 10.9	NOTE 10' 1. DROVE 3X TO 10.9' (REFUSAL) 2. PULLED ALL HSA SET 6" CSG TO 11.5' 3. DRILLED w/ ROLLER BIT (6") TO 12.0. WATER LOSS 30 GAL 11.5'-12.0'
11 .9	L C	APPROXIMATE TOP OF WEATHERED ROCK LIMESTONE (LM) BASED ON CUTTINGS 1.1' LOST DUE TO DRILLING METHOD		12.0	
12	L C	LM, .5 LOST DUE TO WEATHERING & FRACTURES	12.5		
13		TOP OF SL. WEAT. ROCK		RUN #1	NOTE 12
	CIB	LIMESTONE SANDY (SILICEOUS) FOSSILIFEROUS, NUMEROUS CORALS &		R1.5	1. START CORE, RUN #1 AT 12' w/ 4" DOUBLE TUBE & DIAM. BOT. DISCH. BIT
14	CIB	GASTROPODS THIN, HORIZONTAL BEDDING	BOX 1 OF 1	14.0	2. RUN #1 40 GAL LOST 12-12.5
15	NB	YEL BRN 10YR 5/4 HARD			
	NB	WELL CEMENTED		RUN #2	0 LOST 12.5-14
16	NB	DENSE-COARSE GRAINED SCAT (<5%) TIGHT 45° FRACTURES			SOUNDED HOLE 14.0'
17	CIB	NO STAINING SOLID, LOW PRIMARY & SECONDARY PERM. ST. GEORGE FM			NOTE 14 1. RUN #2, COMPLETE, WATER LOSS 18-18.5 (50 GAL)., SH 18.5
18	L C	.5' LOST LM BADLY FRACTURED	18.0 18.5	R4.5 18.5	NOTE 18.5 1. TOO FRACTURED TO CORE, USE GEAR BIT TO 30' 2. LOST 500 GALS 3. HOLE OPEN TO 30' 4. SET WELL, PULLED ALL CASING END 8 NOV 87
.5		11.5' LOST, HIGHLY FRAC. LM (CUTTINGS) V. ROUGH DRILLING	S#8		
30		BOTTOM OF HOLE 30.0			

BORING LOG FORMAT

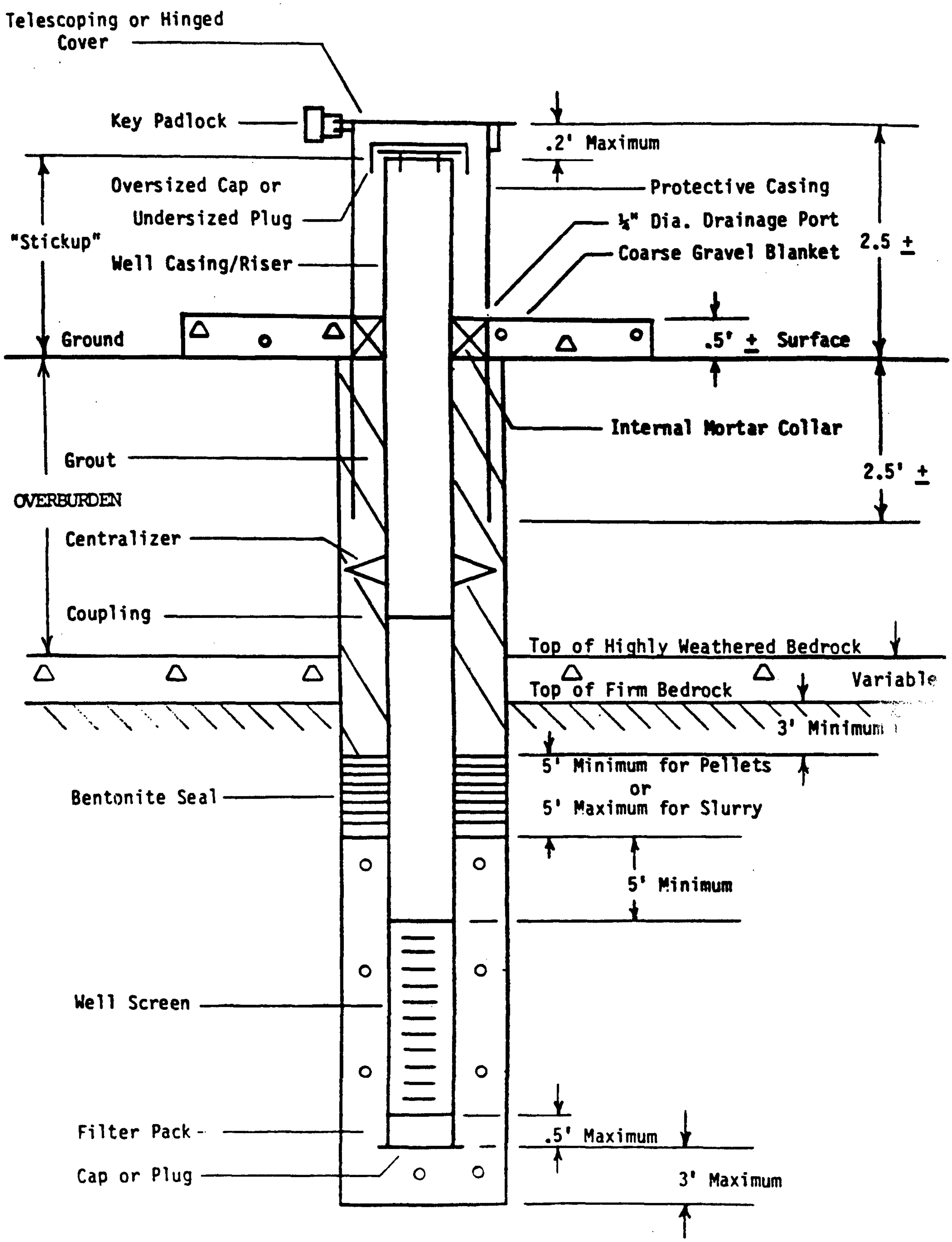
FIGURE 4

Page 3 of 3



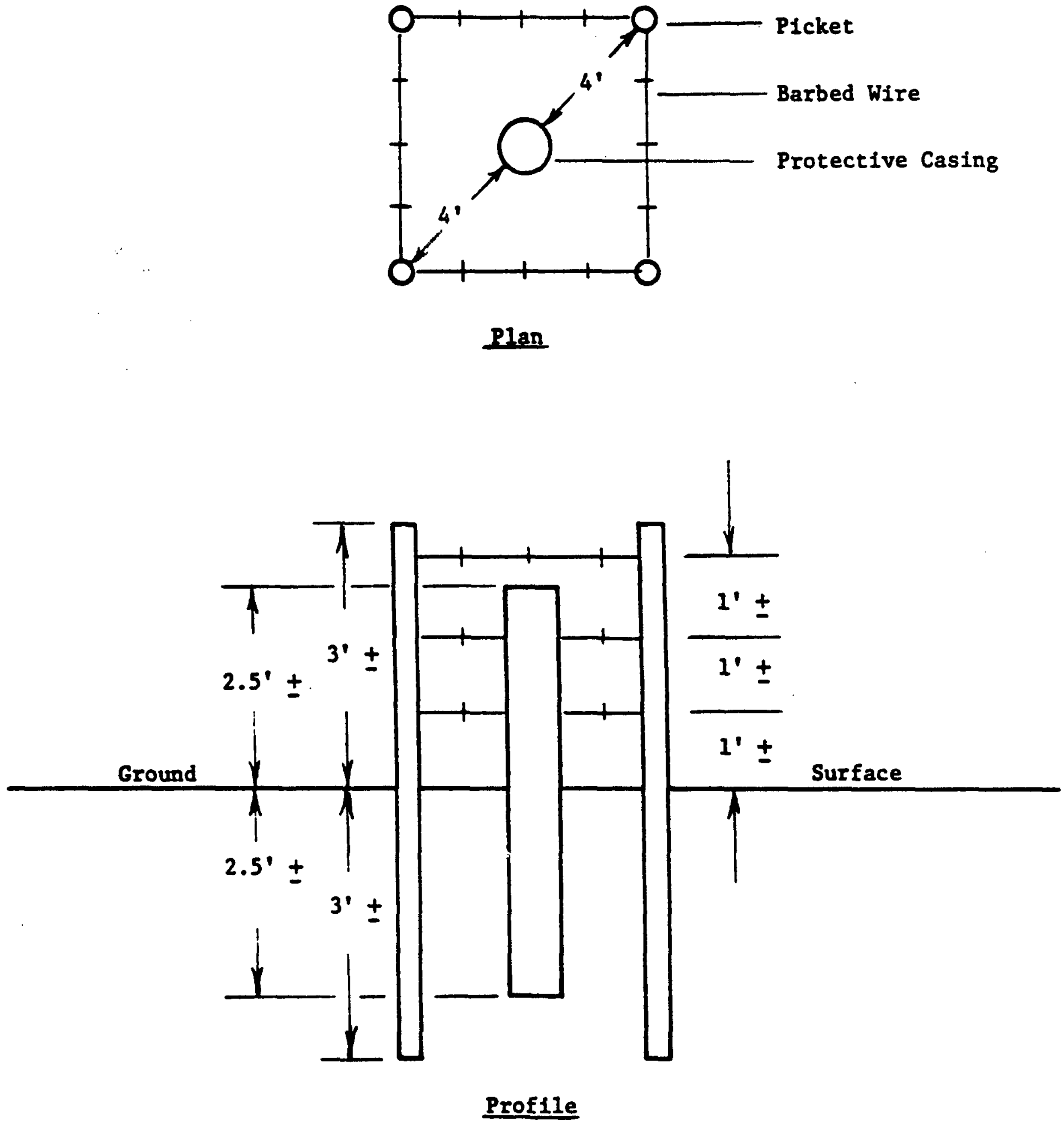
SCHEMATIC CONSTRUCTION OF OVERBURDEN WELL

FIGURE 5

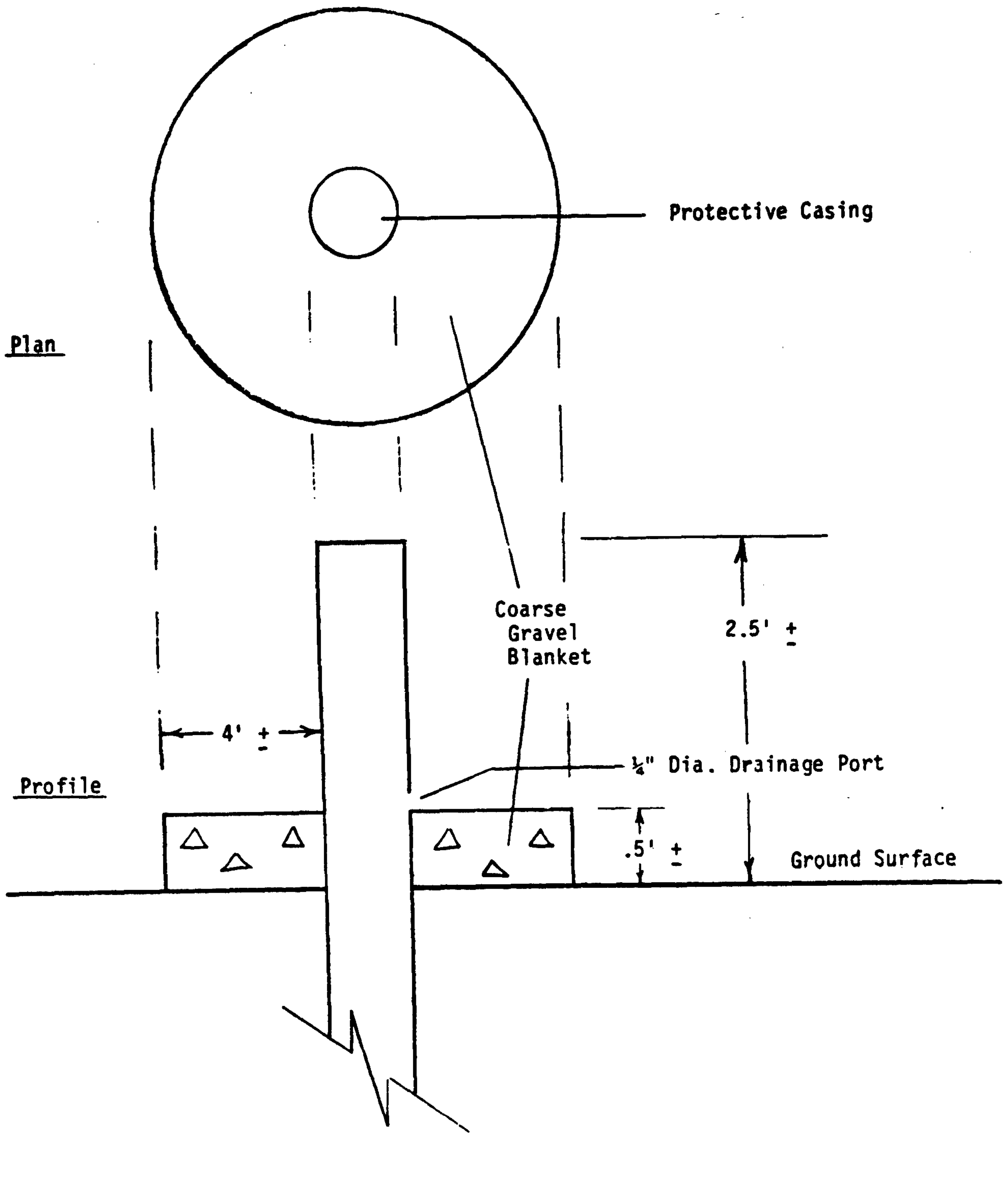


SCHEMATIC CONSTRUCTION OF
BEDROCK WELL

FIGURE 6



PICKET PLACEMENT AROUND WELLS
FIGURE 7



COARSE GRAVEL BLANKET LAYOUT

FIGURE 8

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	3. DISTRIBUTION / AVAILABILITY OF REPORT
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION 6b. OFFICE SYMBOL *(If applicable)*	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS *(City, State, and ZIP Code)*	7b. ADDRESS *(City, State, and ZIP Code)*
8a. NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*

12. PERSONAL AUTHOR(S)

13a. TYPE OF REPORT	13b. TIME COVERED FROM ____ TO ____	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

DD FORM 1473

FIGURE 9

Page 1 of 2

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE *(Include Area Code)* | 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR

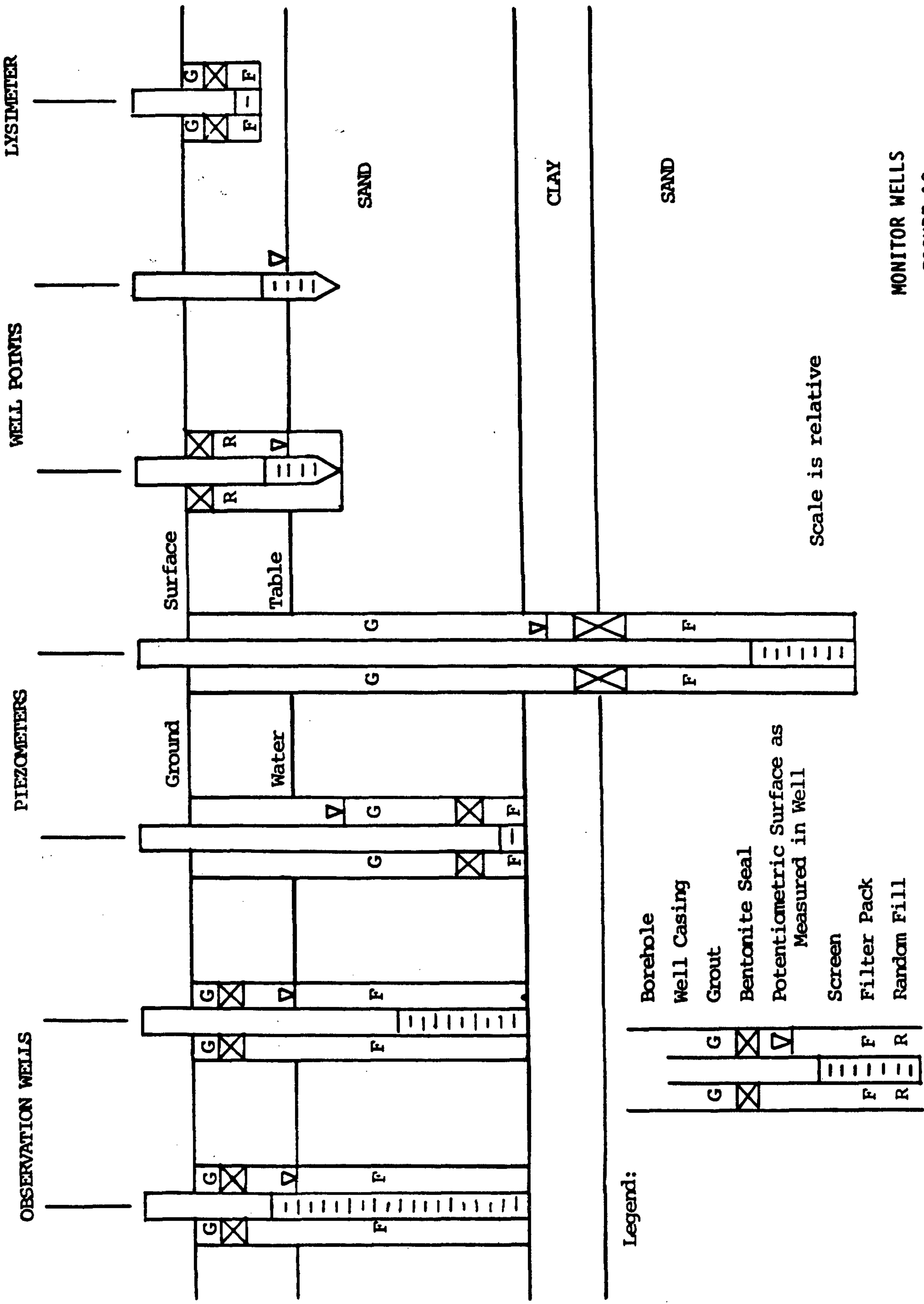
83 APR edition may be used until exhausted.
All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

DD FORM 1473

FIGURE 9

Page 2 of 2



MONITOR WELLS
FIGURE 10

MAP CODING FORM

Installation GP Site Type BORE Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: WELL Pointer Site Id: 87-14
Aquifer id: PALEO
Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (BORE)
FIGURE 11

MAP CODING FORM

Installation GP Site Type WELL Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: BORE Pointer Site Id: 87-14
Aquifer id: PALEO

Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (WELL)

FIGURE 12

INST	FILE TYPE	LAB	INITIALS
GP	GFD	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
BORE	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	GRDWT	01			7.0	FT	
11/08/87	DBRK	01			11.9	FT	
11/08/87	DPTOT	01			30.0	FT	
11/07/87	USCS	01	0.0	.8		FT	OL
11/07/87	USCS	01	0.8	3.8		FT	SM
11/08/87	USCS	01	4.6	3.4		FT	SP
11/08/87	USCS	01	8.0	3.9		FT	GP
11/08/87	USCS	01	11.9	18.1		FT	LMSN
/ /							

FIELD DRILLING FILE CODING SHEET

FIGURE 13

INST	FILE TYPE	LAB	INITIALS
GP	GWC	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
WELL	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	STKUP	01			2.3	FT	
11/08/87	BSEAL	01			5.0	FT	
/ /	CASE	01			25.0	FT	
/ /	CASED	01			.33	FT	
/ /	DPTOT	01			30.0	FT	
/ /	GFILT	01			10.0	FT	
/ /	GROUT	04			15.0	FT	
/ /	SCREN	02			5.0	FT	
/ /							

WELL CONSTRUCTION FILE
CODING SHEET
FIGURE 14

GEOTECHNICAL DATA ENTRY CODING FORM

INST	FILE TYPE	LAB	INITIALS
GP	GGS	AC	JS

UNITS
FT

GROUND WATER
STABILIZED *

SITE TYPE	SITE ID	DATE	DEPTH
WELL	87-14	11/12/87	6.7
WELL	87-14	12/2Ø/87	7.4
WELL	87-14	Ø1/Ø4/88	9.1
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	

* - Depth measured from ground surface

GROUNDWATER STABILIZED FILE
CODING SHEET
FIGURE 15

N. TABLES

TABLE 1

WELL CONSTRUCTION MATERIALS

Material (Example Entries)	Brand/Description (Example Entries)	Source/Supplier (Example Entries)
PVC Casing	4.0" ID, Schedule 40, flush threaded; 2" ID, Schedule 40, flush threaded.	ABC Mfg; Aville, Minnesota
PVC Screen	.05" slot, 4.0" ID, Schedule 40, flush threaded, .02" slot, 2" ID, Schedule 40, flush threaded	ABC Mfg; Aville, Minnesota
Bentonite (drilling fluid and grout)	Tru-gel	A. O. Bentonite, Bville, Wyoming
Granular Bentonite (seal)	Gran-Bent	White Mud, Cville, Montana
Bentonite Pellets (seal)	(No brand name available)	PELBENT, Dville, Utah
Sand (filter pack)	8-12 silica sand	State Sand, Mville, Colorado; supplier: EFG Co. Eville, Utah
Cement (grout)	Portland Type II	A. Lumber Co., Eville, Utah
Drilling Water	St. Peter Sandstone	Production Well #1, Tap at well house General AAP
Drilling Rod Lubricant	Slick Turn	Oil Products Co., Fville, Texas
Air Compressor Oil	Oil #40	Oil Products Co., Fville, Texas

TABLE 2

PROCEDURAL AND MATERIAL APPROVAL SUMMARY

Items Requiring Approval	Reference Section	Time for Approval	Turn Around Time for Geotechnical Evaluation and Recommendation
Drilling Method	III.A.1.c.	Prior to contract/task award	During Proposal/ Bid Evaluation
Air Usage	III.A.2.	Prior to contract/task award	During Proposal/ Bid Evaluation
Bentonite	III.A.10.a.	Prior to drilling equipment arrival onsite	6 Working Days
Water	III.A.10.b.	Prior to drilling equipment arrival onsite	3 Calendar Weeks
Abandonment	III.A.11.	Prior to casing removal or backfilling	4 Consecutive Hours
Borehole Fluids, Cuttings, and Well Water Disposal	III.A.16.	Prior to technical plan acceptance	During Plan Evaluation
Time of Well Installation	III.C.1.	Prior to drilling	3 Working Days
Well Screen and Casing Materials	III.C.2.a.	Prior to contract/task award	During Proposal/ Bid Evaluation
Granular Filter Pack	III.C.5.a.	Prior to drilling	8 Working Hours
Protective Casing, Exceptions	III.C.8.a	Prior to drilling	6 Working Days
Geophysical Procedures	III.G.	Prior to use	Time not specified
Vadose Zone Monitoring	III.H.	Prior to use	Time not specified

TABLE 3

CONTRACTOR DOCUMENT/ITEM SUBMISSION SUMMARY

Document/Item	Reference Section	Submission Time	Submission To
Geotechnical Requirements (modified per contract)	II.A.	With Technical Plan (or equivalent document)	USATHAMA-COR
Licenses of Surveyor and Driller	III.A.5.	With Technical Plan (or equivelent document)	USATHAMA-COR
Submissions to State and/or local authorities	III.A.5.	As required	State and/or local offices coordinated through USATHAMA
Abandonment memorandum (written)	III.A.11.	Within 5 working days of telephonic request	Contracting Officer through USATHAMA
Abandoned boring and/or well record	III.A.11.	Within 3 working days of abandonment	USATHAMA-COR
Soil physical testing results	III.A.12.d.	Within 10 working days of final test	USATHAMA-COR
Rock core photography	III.A.13.	Within 2 weeks of last coring	USATHAMA-COR
Boring logs	III.B.2.	Within 3 working days after boring completion or instrumentation completely installed	USATHAMA-COR
Boring log abbreviations, general legend	III.B.5.v.	With first or last log, as appropriate	USATHAMA-COR
Two keys to padlocks	III.C.8.c.(8)	Upon completion of last well placement	Installation Representative and USATHAMA
Well diagram	III.C.12.c.	Within 3 working days of well/protective measure completion	USATHAMA-COR

TABLE 3 (Cont'd)

Document/Item	Reference Section	Submission Time	Submission To
Well development record	III.D.2.	Within 3 working days after development	USATHAMA-COR
Well development water sample	III.D.10.	Within 3 working days after developing that well	USATHAMA-designated individual
Geotechnical Report(s)	III.K.	As required per contract or task.	Contracting Officer through USATHAMA

APPENDIX B

SAMPLE SUMMARY FOR FORT DEVENS SI

Appendix B
Sample Summary For Fort Devens SI
This list includes original and contract mod. requirements

Site Type	Site ID	Description	VOA	Semi VOAs	Pest /PCB	TAL Metals	EXP	TOC	TPH	TCLP	ION	Hardness	Total Suspend Solids	Water Quality Cl,N2,NO3,SO4,P	Rinsate Sample	MS/ MSD	MS/ Lab	DO	Temp	PH	Spec Cond	Grain Size	Geotech Samples
			Analytical Parameters												QA Parameters			Field Parameters					
** Study Area # 15																							
* Matrix Source Is A BORE																							
BORE	LF11-01-01	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-02	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-03	Soil Boring	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-04	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-05	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-06	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-07	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-08	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-09	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-01-10	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
BORE	LF11-02-01	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-02	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-03	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-04	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-05	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1
BORE	LF11-02-06	Soil Boring+dupe	2	2	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-07	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-08	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-09	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-02-10	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-01	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-02	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-03	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-04	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-05	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-06	Soil Boring+dupe	2	2	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-07	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-08	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-09	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-03-10	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
BORE	LF11-04-01	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-02	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-03	Soil Boring	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-04	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-05	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-06	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-07	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-08	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-09	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	LF11-04-10	Soil Boring	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1

(every 2½ ft to 25)

Appendix B
Sample Summary For Fort Devens SI
This list includes original and contract mod. requirements

Site Type	Site ID	Description	Analytical Parameters: VOA	Semi VOAs	Pest /PCB	TAL Metals	EXP	TOC	TPH	TCLP	ION	Hardness	Total Suspend Solids	Water Quality Cl,N2,NO3,SO4,P	QA Parameters: Rinsate Sample	MS/ MSD	MS/ Lab	Field Parameters: DO	Temp	PH	Spec Cond	Grain Size	Geotech Samples
** Study Area # 24																							
* Matrix Source Is A AREA																							
AREA	B187-1	Surface Soil	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	B187-2	Surface Soil	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	B187-3	Surface Soil	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	B187-4	Surface Soil+dupe	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	B187-5	Surface Soil	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
** Study Area # 25																							
* Matrix Source Is A WELL																							
WELL	EOD-1	Nearest Burn Pit	2	2	2	2	2	0	2	0	2	0	0	0	0	1	1	2	2	2	2	0	0
WELL	EOD-2	Downgradient Well	2	2	2	2	2	0	2	0	2	0	0	0	0	0	0	2	2	2	2	0	0
WELL	EOD-3	Central Well	2	2	2	2	2	0	2	0	2	0	0	0	0	0	0	2	2	2	2	0	0
WELL	EOD-4	Access rd+dupe	2	2	2	3	3	0	3	0	3	0	0	0	2	0	0	2	2	2	2	0	0
** Study Area # 26																							
* Matrix Source Is A BORE																							
BORE	ZULU2-01-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-01-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-01-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-02-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-02-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-02-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-03-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-03-2	4-5'+dupe	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-03-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-04-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-04-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-04-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-05-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-05-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-05-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-06-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
BORE	ZULU2-06-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-06-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-07-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-07-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-07-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-08-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-08-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-08-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-09-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-09-2	4-5'+dupe	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-09-3	9-10'+TCLP	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU2-10-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU2-10-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix B
Sample Summary For Fort Devens SI
This list includes original and contract mod. requirements

			Analytical Parameters												QA Parameters			Field Parameters					
Site Type	Site ID	Description	VOA	Semi VOAs	Pest /PCB	TAL Metals	EXP	TOC	TPH	TCLP	ION	Hard ness	Total Suspend Solids	Water Quality Cl,N2,NO3,SO4,P	Rinsate Sample	MS/ MSD	MS/ Lab	DO	Temp	PH	Spec Cond	Grain Size	Geotech Samples
BORE	ZULU2-10-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
BORE	ZULU1-01-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-01-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-01-3	9-10'+dupe	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-02-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-02-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-02-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-03-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-03-2	4-5'+TCLP	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-03-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-04-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-04-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
BORE	ZULU1-04-3	9-10'+dupe	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-05-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-05-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-05-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-06-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-06-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-06-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-07-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-07-2	4-5'+TCLP	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-07-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
BORE	ZULU1-08-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-08-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-08-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-09-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-09-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-09-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-10-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-10-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-10-3	9-10'+TCLP+Dupe	1	1	1	1	1	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	1
BORE	ZULU1-11-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-11-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-11-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-12-1	0-6 in	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	ZULU1-12-2	4-5'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BORE	ZULU1-12-3	9-10'	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
* Matrix Source Is A POND																							
POND	SE-ZULU1-1	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
POND	SE-ZULU1-2	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
POND	SE-ZULU1-3	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0
POND	SE-ZULU1-4	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
POND	SE-ZULU1-5	SurfSediment+Dupe	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0
POND	SE-ZULU1-6	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
POND	SE-ZULU1-7	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
POND	SE-ZULU1-8	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Appendix B
Sample Summary For Fort Devens SI
This list includes original and contract mod. requirements

Site Type	Site ID	Description	Analytical Parameters												QA Parameters			Field Parameters					
			VOA	Semi VOAs	Pest /PCB	TAL Metals	EXP	TOC	TPH	TCLP	ION	Hardness	Total Suspend Solids	Water Quality Cl,N2,NO3,SO4,P	Rinsate Sample	MS/ MSD	MS/ Lab	DO	Temp	PH	Spec Cond	Grain Size	Geotech Samples
POND	SE-ZULU2-1	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
POND	SE-ZULU2-2	Surface Sediment	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
POND	SW-ZULU1-1	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU1-2	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU1-3	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	1	1	1	1	1	1	0	0
POND	SW-ZULU1-4	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU1-5	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU1-6	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU1-7	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU1-8	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU2-1	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
POND	SW-ZULU2-2	Surface Water	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	1	1	1	1	0	0
** Study Area # 32																							
* Matrix Source Is A AREA																							
AREA	DRMO-1	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-2	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-3	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-4	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-5	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-6	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-7	0-6"	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-8	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-9	0-6"	1	1	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
AREA	DRMO-10	0-6"+Dupe	2	2	2	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	DRMO-11	0-6"	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
** Study Area # 48																							
* Matrix Source Is A BORE																							
BORE	B202-BH1-1	0-5'	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	B202-BH1-2	5-10'	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	B202-BH1-3	10-15'	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	B202-BH1-4	15-20'	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	B202-BH1-5	20-25'+DUPE	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	B202-BH1-6	25-30'	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORE	B202-BH1-7	30-35'	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* Matrix Source Is A WELL																							
WELL	B202-1	Bkg Well	2	2	2	2	0	0	2	0	2	0	0	0	0	1	0	2	2	2	2	0	0
WELL	B202-2	N Corner +DUPE	3	3	3	3	0	0	3	0	3	0	0	0	0	0	0	3	3	3	3	0	0
WELL	B202-3	W Fence +DUPE	3	3	3	3	0	0	3	0	3	0	0	0	0	0	0	3	3	3	3	0	0

Appendix B
Sample Summary For Fort Devens SI
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			Analytical Parameters												QA Parameters			Field Parameters						
Site Type	Site ID	Description	VOA	Semi VOAs	Pest /PCB	TAL Metals	EXP	TOC	TPH	TCLP	ION	Hardness	Total Suspend Solids	Water Quality Cl,N2,NO3,SO4,P	Rinsate Sample	MS/ MSD	MS/ Lab	DO	Temp	PH	Spec Cond	Grain Size	Geotech Samples
** Study Area # 25																							
* Matrix Source Is A BORE																							
BORE	EOD-1	Nearest burn pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
BORE	EOD-2	Downgradient	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
BORE	EOD-3	Central Well	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
BORE	EOD-4	Access road	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8